POWER

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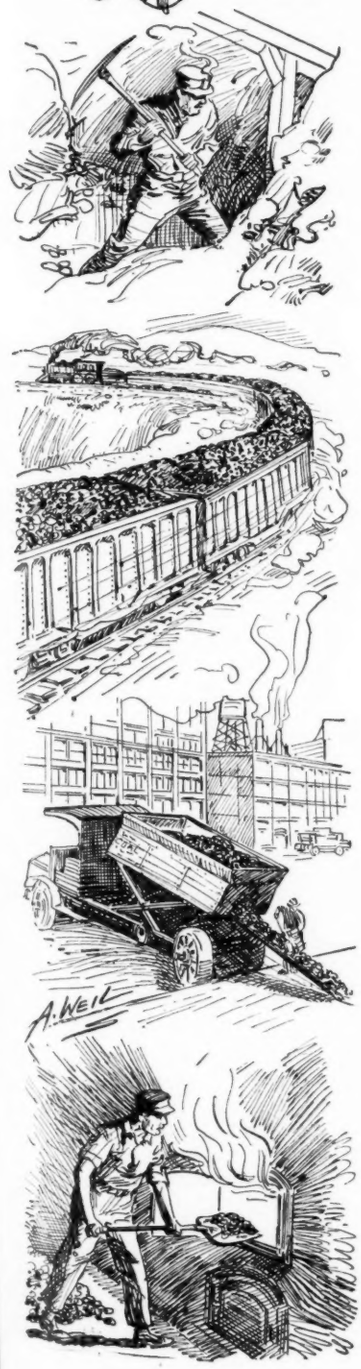
The Greatest Ally

By RUFUS T. STROHM



FROM crowded cities and scattered farms,
With sobered spirits and simple trust,
The thousands answer the call to arms
To humble tyranny in the dust;
But all their courage and all their strength
May yet come short of the final goal,
Since every effort depends at length
On COAL.

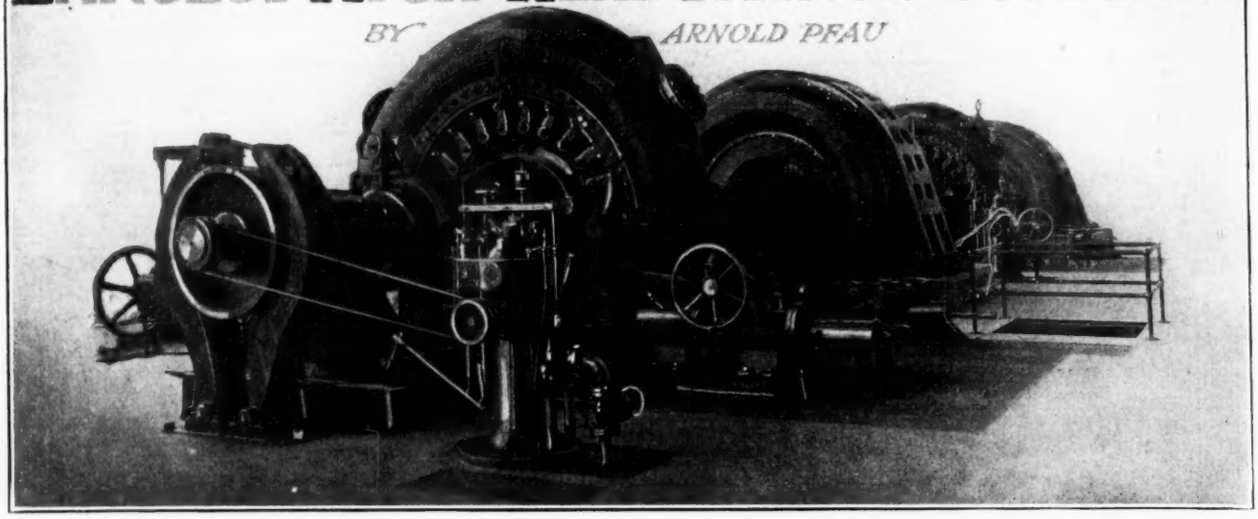
FOR every loyal and sturdy son
Must be accoutered from head to heel
In regimentals of drab and dun
With belt and rifle and blade of steel;
But looms and spindles are still and dead
And forge nor furnace can give its dole
Till boiler fires are gleaming red
With COAL.

WITHOUT its power by rail and sea,
The richest harvest of fruit and grain
Would waste and molder on bush and tree
And rot ungarnered on hill and plain;
While shot and shrapnel that burst afield
Would cease their thunder and crash and roll
If mine and stripping should curb their yield
Of COAL.

FOR coal unleashes the force of steam
That drives the engine and turns the shaft
And pricks the night with the blinding beam
That stabs and searches for hostile craft;
But cold and famine bestride the earth,
And want and suffering claim their toll,
When through disaster there comes a dearth
Of COAL.

LARGEST HIGH-HEAD FRANCIS TURBINE

BY ARNOLD PFAU



The hydro-electric equipment installed in the White River plant of the Puget Sound Traction, Light and Power Co., near Sumner, Wash., is described. This plant contains two 18,000-hp. Francis turbines operating under a net head of 440 ft., which have developed over 44,000 hp. without any detriment to their efficiency. On account of the hydraulic conditions special engineering problems were involved, which have been solved by special features in design. A new 25,000-hp. unit is now being installed, which is the largest hydraulic turbine of this type in the world.

THE commercial results obtained from the electrified operation of the Rocky Mountain Division of the Chicago, Milwaukee and St. Paul Ry. have been so eminently satisfactory that it was decided to immediately proceed with the electrification of the Cascade Mountain division, which extends from Othello, east of the Columbia River, over the Cascades, to the end of the transcontinental line at Seattle and Tacoma. The western slope of the Cascade Mountain division will receive about 25,000 kw. of electrical energy from the Puget Sound Traction, Light and Power Co., at Seattle, Wash. This concern has a number of hydro-electric developments, the largest of which is the so-called White River plant near Sumner, Wash. The plant (see headpiece) with an initially rated output of 36,000 hp., developed by two hydro-electric units, designed and built by the Allis-Chalmers Manufacturing Co., was placed in commercial operation in November, 1911 (Stone & Webster, Engineers), and has since delivered power uninterruptedly and without requiring any repairs. It has been found that the turbines and generators can carry, without difficulty or detriment to their efficiency, a total load of 30,000 kw., or over 44,000 hp. on the shaft. Figs. 1 to 4 show a 25,000-hp. unit recently built, to be installed in this plant, which is the most powerful high-head Francis turbine in the world and is practically a duplicate of the two 18,000-hp. machines already in service.

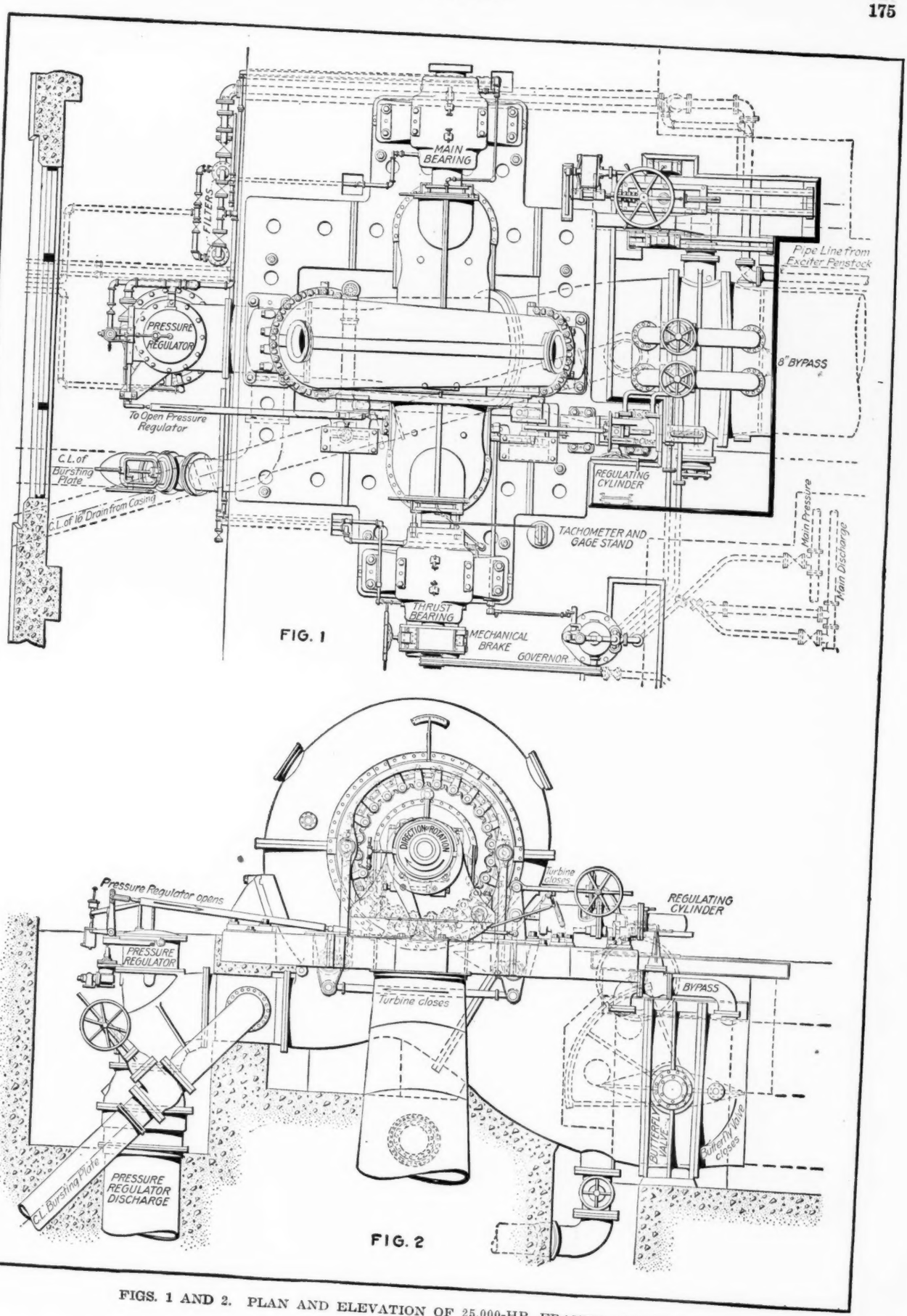
The plant has been laid out with a view of maintaining the highest economy of water, since it is combined with a large storage capacity, which serves to furnish the necessary operating water during dry seasons. The course of the White River, a typical mountain stream fed from one of the glaciers of Mount Rainier, is blocked by a timber-crib dam near Buckley, Wash., on one of the branches of the Northern Pacific's transcontinental line. The water is controlled by sturdy steel gates and led through a heavy timber flume into a forebay, which serves as a settling basin for the glacial silt, carried by the river at times in large quantities. Provision is made for draining and flushing this forebay to prevent its being filled up with deposits.

An open canal leads to the storage reservoir, called Lake Tapps, which was a small natural lake, now greatly enlarged by raising its water level about 35 ft., bringing its storage capacity up to 2,250,000,000 cu.ft., equivalent to 18,000,000 kw.-hr. obtained under the net head of 440 feet.

From Lake Tapps the water is carried through a deep open cut and a tunnel about 3000 ft. long and of sufficient area to carry 3000 cu.ft. of water per second. The tunnel ends in a forebay from which individual 8-ft. steel-pipe lines lead down to the power house.

In order to adhere to the principle of conservation of stored hydraulic energy of this plant, it was necessary to provide hydraulic equipment which is capable of controlling the bulk of the momentary variation of the commercial load of the Puget Sound Traction System. This variation is sometimes very severe, owing to rapid and large changes of the power required by the freight trains of the Puget Sound lines.

The long tunnel combined with the steel pipe lines, about 2500 ft. in length each, together with the requirement of a water-saving method of speed regulation under heavy fluctuations of load over a high-tension transmission line, offered a problem to the hydro-mechanical engineer, which required careful study and practical experience.



FIGS. 1 AND 2. PLAN AND ELEVATION OF 25,000-HP. FRANCIS TURBINE

In order to prevent excessive variations in speed and voltage of the power system, it was necessary to use a very sensitive governor and to quickly control the gates of the turbine. A sudden change in the flow of the water through the pipe lines and tunnel would

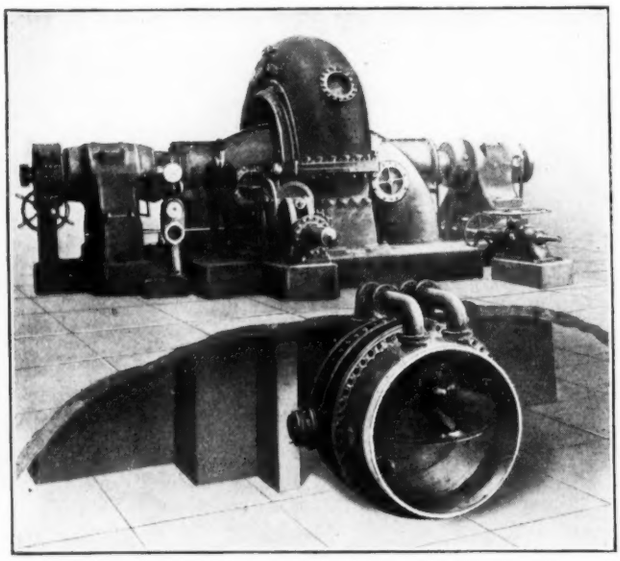


FIG. 3. COMPLETE TURBINE AND BUTTERFLY VALVE

cause pressure variations which would not only impair the regulation, but might accumulate to such an extent as to wreck the whole plant. A careful analysis of all the precautionary methods was made, and as a result it was decided to use:

1. A surge reservoir at the end of the tunnel for the purpose of preventing surges set up by the tunnel from materially affecting the pressure in the pipe lines and vice versa.

2. Pressure regulators so combined with the turbines that they permit of a sudden release of the water, otherwise brought to a stop when the governor closes the gates of the turbines quickly. In order to prevent excessive waste of water, these releases or bypasses slowly and automatically close at a rate so adjusted that the flow of water is gradually stopped without causing any appreciable secondary-pressure rises.

3. Air-cushion tanks, which supply hydraulic energy to the turbines when the demand of load is so sudden that the water cannot accelerate in the pipe line sufficiently fast to prevent a serious drop in pressure.

The proper combination of these devices, together with a fairly liberal flywheel effect of the revolving parts of the generators, made it possible to attain an accuracy in speed regulation which has been the subject of considerable comment in engineering circles.

The turbines of the initial installation are of the double-discharge, horizontal-shaft spiral-case type operating under a net head of 440 ft. at 360 r.p.m., similar to the unit shown in the figures.

The water from the penstock passes through a steel butterfly valve, shown in Figs. 1 and 2 and below the turbine in Fig. 3, of seven feet inside diameter, which, when closed by hand or electrically, is sufficiently tight to permit inspection of the interior of the turbine. The total normal pressure on the gate of this valve is about 1,000,000 lb. and it is far in excess of this when the valve is closed against the full penstock pressure in emergency cases. The water is brought to the runner through a steel casing of the scroll type, this being the most efficient method because the flow of water is steady and direct. Before reaching the runner, the water passes between a series of steel guide vanes or wicket gates, by means of which the quantity is quickly changed by the governor in accordance with the load to be carried by the generator.

The steel runner of the turbine is bolted to a flange forged solid with the turbine shaft and is of the double-discharge type, dividing the incoming water into two equal portions which discharge separately through a quarter turn and a tapered steel draft tube. The shaft revolves in two ring-oiling bearings with self-aligning ball-and-socket seats, one end having a solid flange for direct connection to the generator. The opposite end carries the mechanical hand brake (see headpiece and Figs. 1 and 3) for bringing the unit to a dead stop. The bearing near the brake serves also as a mechanical thrust bearing; the main thrust, however, is taken care of automatically by means of a simple and very efficient hydraulic balancing arrangement combined with the two runner rims and the adjacent portions of the stationary cover plates.

The spiral casing, quarter turns, bearings and brake are bolted to a heavy cast-iron bedplate, grouted into the foundation. The guide vanes are held in three bearings and are operated from a concentric steel shifting ring located outside of the casing. Two steel rods connect the shifting ring to bell-crank levers which in turn are actuated by a regulating piston guided by a crosshead. The oil pressure acting on both sides of the

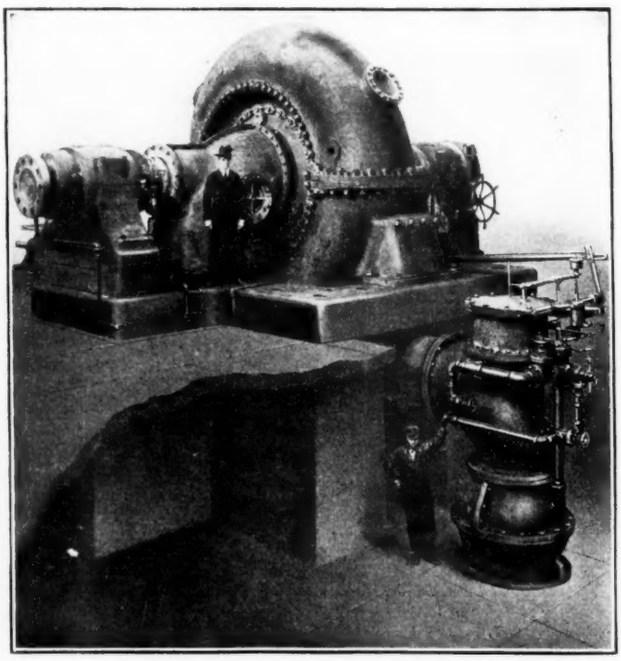


FIG. 4. COMPLETE TURBINE AND PRESSURE REGULATOR

regulating piston is controlled by a double-acting, hydraulically balanced regulating valve bolted to the separate governor stand, Fig. 5, containing the flyballs and the relay of the governing device. The oil pressure is obtained from a central oil-pressure system located in the basement of the plant. It is produced

in pumps of the rotary-gear type driven by electric motors or by a small waterwheel operated from the penstock pressure. The governor has a capacity of about 50,000 ft.-lb. and is capable of moving the turbine gates over their full stroke in one second.

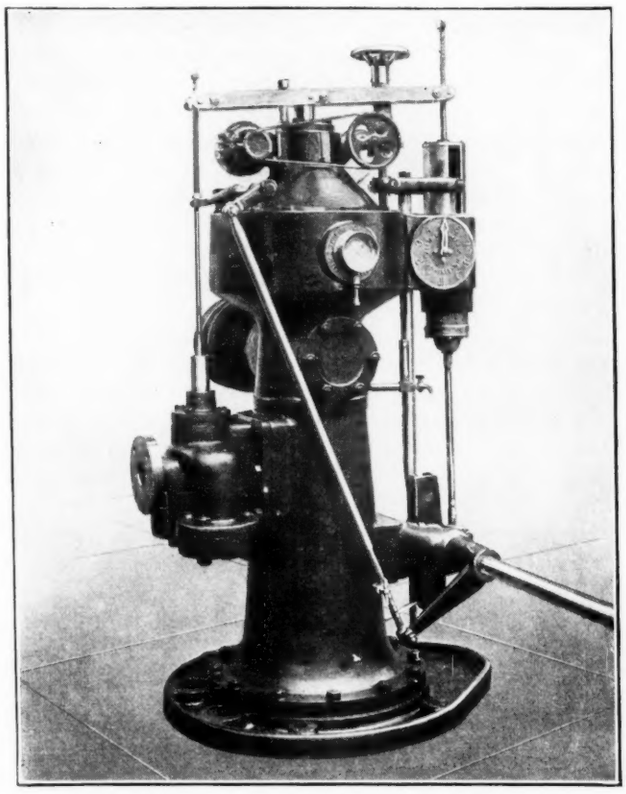


FIG. 5. GOVERNOR ACTUATOR FOR 25,000-HP. TURBINE

A pressure regulator (see Figs. 1, 2 and 4) is directly connected to a branch pipe provided on the lower portion of the spiral casing. It consists of an elbow with a circular disk valve, opening and discharging water downwardly through a plate-steel pipe into the tailrace. This disk valve is connected to a piston subjected to water pressure controlled by a regulating valve, which in turn is relay-operated from a direct connection to the turbine gates. An oil dashpot is so inserted into this connection that the motion of the turbine gates is transmitted to the regulating valve only when the governor closes the former quickly, a slow motion only being completely absorbed in the dashpot. Thus the discharge of the turbine can be quickly switched over from the turbine to the pressure regulator, and is there reduced slowly in accordance with the setting of the bypass in the oil dashpot, determining the rate of the closing motion.

The turbine discharges about 450 cu.ft. of water per second, and when the flow is stopped through the turbine gates in 1.5 sec., it will discharge through the pressure regulator to its full amount by the time the governor has closed the turbine gates. Thus the velocity of the water in the pipe line is not changed abruptly and no serious pressure rises occur.

After the units were placed in commercial operation, elaborate efficiency and regulation tests were carried out by the owner. It was found that the efficiency exceeded 90 per cent. and was still above 80 per cent. at about one-fifth load.

The full load of 20,000 hp. was thrown off suddenly, causing the governor to close the gates quickly. The speed did not rise more than 12 per cent. above normal, and the maximum pressure rise in the pipe line above normal did not exceed 5.5 per cent. as against a guaranteed pressure rise of 15 per cent. and a speed rise of 18 per cent.

After five years of continuous service one of these turbines was opened up for careful examination. The parts subject to hydraulic and mechanical wear were measured up and photographs taken in order to establish their durability. The unit was taken out of service Saturday evening and was delivering its regular power again after midnight, Sunday. No repairs whatever were considered necessary, and it was estimated that it would be good for another five years of continuous service under similar conditions.

The results of this examination were so gratifying that it was decided to build the new third unit, practically a duplicate of the first two. The results obtained as regards efficiency and speed regulation encouraged the purchaser to increase the rated horsepower from 18,000 of the original contract to 24,000 without increasing any parts except those directly affected, such as the runner, shafts, guide vanes, etc. It is expected that 25,000 hp. will be delivered to the generator shaft and that both the efficiency and the speed regulation will be at least as good as they are with the first units.

Conserving Waste Heat

Economists are continually calling attention to the necessity for intensified conservation of resources and greater efficiency in our methods of development. As respects the conservation of heat, it is doubtful if the manufacturers of reciprocating steam engines are giving that study to the saving of the heat of exhaust steam which their interest demands. The practicable savings through higher pressures, increased expansion, superheat, improved vacuum, reduced cylinder condensation and radiation are fairly well realized, but all these are nothing as compared with the potential conservation of the heat of exhaust. Here is presented to the engineer an extended field for endeavor. Where this heat is available for heating or mechanical purposes, the thermal efficiency of the reciprocating engine is vastly beyond that of the Diesel or any internal-combustion engine. Power then becomes a byproduct and the use of any other heat engine is prohibited. By persistent exploitation of this field a new lease of life for the languishing engine trade is possible. It devolves upon the steam engineer to extend the application of waste heat. He should consolidate the diversified industries in such a way that the manufacturer requiring power will take his modicum of heat from the steam and pass the remainder on to his neighbor, for use in mechanical or other processes. At the present time, we utilize, on an average, only 5 per cent. of the heat value of coal. The combustion engineer is rapidly whipping the boiler end of the steam plant into shape; an exhaust engineer is now in demand to coin into money the waste at the exhaust end—*Steam*.

While the Idle Millions Shiver

An exposition of the deplorable conditions at the great coal terminal at Perth Amboy, N. J., from which coal for New York and lower New England is shipped by water after arrival at the terminal by rail.

WALK slowly along the east side of Ninth Avenue between 34th and 35th Streets any day from daylight until after darkness falls and you will see a line of shivering wretchedness.

It is a coal line. It is a full block long and three persons wide. You find there aged women, rheumatic old men, sturdy workmen, young women, young men and belligerent yet laughing children. Each has a bag or a box, a wash boiler, baby carriage, trunk—anything to hold the treasure coal that is portioned out to each while three policemen preserve order. Be there snow, or rain or wind and biting cold, the shivering line is there.

Having seen the woeful coal lines and experienced the shock of the Garfield order, let us see the conditions at the great coal-distribution center that supplies Greater New York and lower New England, as seen by two *Power* representatives on the day the Garfield order went into effect. These are anthracite-consuming sections for the most part. The distribution centers are Perth Amboy and South Amboy, on the New Jersey coast, the former handling hard coal, the latter soft coal almost exclusively. The coal comes from Pennsylvania to the water front by rail and is there transferred to barges which take it to the New York and New England waterfronts. It is not more than twenty miles from Manhattan Island to Perth Amboy—a short tow.

The waterways from the coal-unloading piers have been seriously obstructed with ice; but at the time of our visit they were free. At the docks near the unloading piers was one group of 55 empty barges, averaging 850 tons each. Farther to the left were other groups of a few barges each. Some had just come in, but the

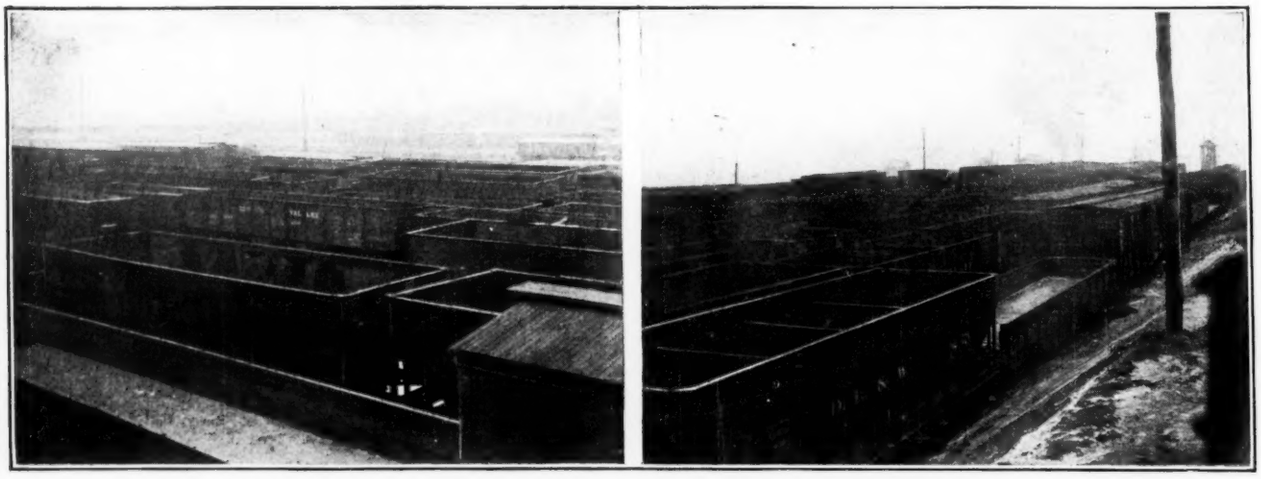


FIG. 1. VIEW OF EMPTY CARS, LOOKING EAST AND WEST, PERTH AMBOY, N. J.

Imagine standing in that line for hours, waiting, waiting, eagerly, hopefully watching for the coming of a two-ton wagon only to see it come in—empty! That happens.

This line is but one of hundreds in that city of six million souls, and it is truly indicative of the cruel suffering throughout the whole of the greater city and the country.

That line has nothing to do with power. But the industries, the buildings, the schools and hospitals are waiting in line just as are these stamping, crying people. And this not only in New York, but from the Atlantic to the Pacific.

This is written on the day following the collapse of industry and commerce at the order of the Fuel Administrator. We are not arguing the expediency of that order, for we believe that as a measure to relieve rail and terminal congestion it is warranted. It cannot have been issued to conserve fuel because for this purpose it is too obviously doomed to failure even for contemplation.

greater number had been there many days. To make the irony of the situation most stinging, the "Hurry Up," of New York, had been there 27 days up to Jan. 18, the day of our visit. Demurrage of 5 cents per day per ton capacity is what the coal consumer must pay—is what those wretches in the coal line must pay. The capacity of the "Hurry Up" is about five hundred tons. Twenty-seven days' demurrage means that the consumer of the coal she gets must pay $1.35 per ton, not for coal, but for demurrage. Fig. 2 shows some empty barges.

And this while thousands and thousands of tons of coal stand in cars at the unloading piers not a thousand feet away, and while well above 300,000 tons lie farther back along the rails waiting to come in. (See Fig. 1.)

It is to weep!

At Perth Amboy there are two unloading piers where coal is dumped from the cars to the barges. One pier has a machine unloader which lifts and dumps one carload at a time. At the other or large pier the cars are unloaded by hand. There are thirty chuteways down which the coal may run to the barges below. On the

day of our visit three were being used—the pier working at one-tenth full capacity. True, a few chutes are missing from the chuteways; but their absence only adds to the neglect so strikingly, so astoundingly, manifest.

Six men per car is the crew used in unloading the frozen coal. Twenty-six men were all that were working on that pier unloading on Jan. 18. There should have been six times as many.

The coal is frozen solid in the cars, and the finer the coal the more solid the frozen mass. Back at the entrance end of the pier are 114 steam thawing heads, all piped, valved and ready for use. Four were in use during the time of our visit. Two cars had one steam lance each stuck into the middle of the coal, and one car was using two lances. It is easily possible to so place cars that four lances per car may be used.

Frozen coal is the most serious cause of the delay in unloading and of the congestion which, remember, affects not only those local yards, but the whole line back

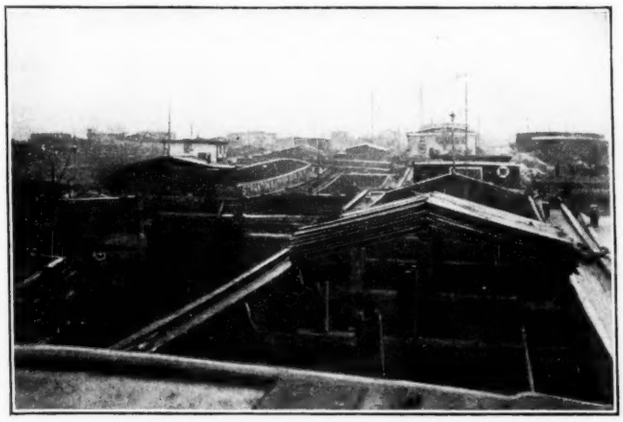


FIG. 2. A FEW OF THE MANY EMPTY BARGES

to the very mines, where lack of cars to reecive their coal is causing miners to walk the streets even while this is written. And this while the shivering coal lines wait and weep; while industry dumps its fires and the victims of enforced idleness shiver and, in many instances, lose the wages with which they hoped to buy coal.

But this is not the worst. The writer got into a car of culm on the pier, which the crew, gone to lunch, were unloading. He picked at it with pickax and bar. It was as hard as concrete. Six men have been allowed to spend two full days unloading a car of culm! They were unloading it while we were there. Think of it. Six men two days unloading one car of culm while that shivering line pleads for the nut and stove and pea and egg that lies by the thousands of tons right at this very pier. Fig. 3 shows the little ice in the bay.

No attempt seems to be made to sidetrack the frozen culm until the other grades which, though equally frozen, may, because of the larger particles, be unloaded ten, aye, fifty times as fast. And then there is the relative heating value. Fig. 4 shows frozen culm.

As things are managed now, a dealer must have his barges on the spot or he can get no coal. If one or a hundred cars of his coal come into the yards and his barges are not there, the coal remains in the cars until *his* barges arrive.

They work nine or ten hours a day on this pier, and if it is worked at over one-tenth its capacity there were

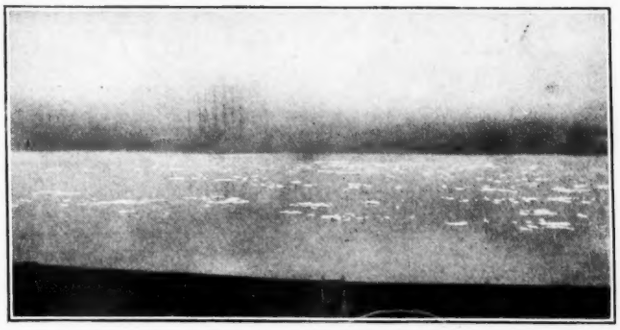


FIG. 3. THE ICE IN THE BAY IS NEGLIGIBLE

no evidences of it when we were there. Why has not someone provided for 24-hour day operation?

The machine-unloading pier works very slowly owing to the coal being frozen.

At South Amboy, the soft-coal terminal, there is every evidence of adequate and proper equipment, of organization, directive intelligence and adequate labor. There are three thawing sheds, while at Perth Amboy there is no thawing shed.

One who knows something of the bitter suffering, of the idleness, of the loss of production and the general serious disturbance of the whole social, economic and industrial fabric, wonders if the conditions described in the foregoing are general. He cannot but seek a motive for it all. It is preposterous to say that the conditions at Perth Amboy simply happen.

The Fuel Administration may know the answer. The public rightly assumes that it does, and it rightly expects it to lose no time in correcting such conditions.

Through it all one thought frequently creeps into the fore of the writer's mind: Some of the public utilities tried hard to get coal, to keep going. They pleaded, demanded and finally precipitated a crisis by turning off the lights and stopping the industries. Then came action. If that shivering line, that line of humans and of buildings, hospitals and industries discover too many Perth Amboys, how long before it will precipitate a crisis as only the constituents of such a line can precipitate it?

It is worth pondering over, Dr. Garfield.

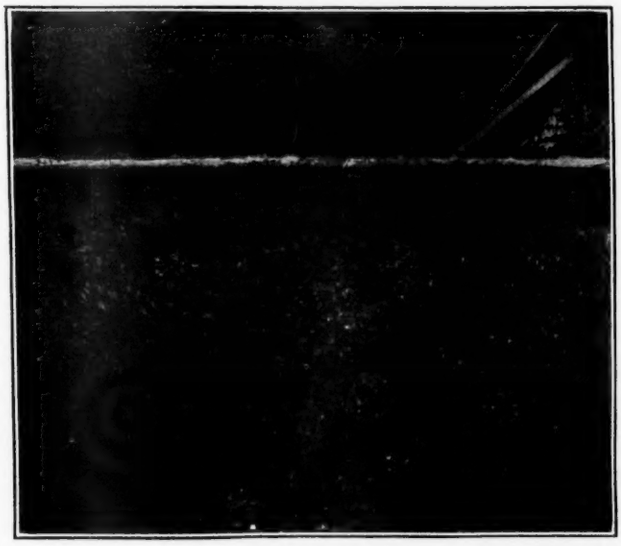


FIG. 4. CULM FROZEN AS HARD AS CONCRETE

Alternating-Current Automatic Starters for Squirrel-Cage Induction Motors

By W. H. PATTERSON
Manager Resale Section, Industrial Department, Westinghouse Electric and Manufacturing Company

An explanation of the operation of an automatic alternating-current starter for squirrel-cage type induction motors. Some of its applications and limitations are pointed out.

ALTERNATING-CURRENT automatic starters are now quite commonly used for squirrel-cage induction motors, especially where it is desired to start the motor from a remote point, such as a motor driving a centrifugal pump, an air compressor, a fan or a blower.

One type of these starters, built by the Westinghouse Electric and Manufacturing Co., consists of a slate panel, Fig. 1, upon which are mounted two alternating-current contact switches—one two-pole switch R and one four-pole switch S. Both these switches are equipped with magnetic blowouts for quickly destroying the arc when opening the switch. An accelerating relay H, a transfer relay T and a no-voltage protection relay P are also mounted on the panel. Either fuses or overload relays are mounted on the panel to protect the motors from overload. In Fig. 1 fuses F are shown on the front of the panel, and in the wiring diagram, Fig. 2, two overload relays O and O_1 are used. An auto-transformer is mounted on the rear of the panel. Fig. 2 shows a complete wiring diagram of the controller for starting a two-phase motor. With the line switch closed and all contactors on the controller in their normal position, all circuits through the controller and to the motor are open. The different steps in the operation of the controller are explained as follows:

Closing the start push-button, as in Fig. 3, establishes a circuit through the operating coil of the no-voltage protection relay P. This circuit is established from L_1 of the supply circuit through the contact on overload relay O, down to 9 on the no-voltage protection relay P, through this coil up to the contact on the overload relay O_1, then down to the start push-button to the stop push-button, which is normally closed, back to L_2 terminal on the control board, and to the other side of the supply circuit L_2 on the line switch, as indicated by the arrowhead. This energizes the coil on the no-voltage protection relay P and causes it to close its contact L and the auxiliary contact 11-12 at the bottom of the relay, as in Fig. 4. Closing contact 11-12 establishes a holding circuit for the relay coil P. This circuit is the same as in Fig. 3 excepting, instead of the current passing from terminal 11 on the controller down to the starting button, it goes through the auxiliary contact 11-12 on relay P and to terminal 12 on the stop button, through this button back to L_2 terminal on the line switch, as indicated. This shunts out the starting button; therefore it can be released and allowed to take its normally open position, without in any way interfering with the operation of the controller.

The closing of the no-voltage protection-relay contact L also establishes a circuit through the operating coil X of the four-contactor switch S. This circuit is made from L_1 of the supply circuit, through the contact of the no-voltage protection relay, to terminal 6 on coil X, through this coil and up to point 1 on the transfer relay T, then to point L_2 on the transfer relay, which is directly connected to L_2 on the supply circuit, as shown by the arrowheads. Energizing coil X causes it to close the four-contactor switch S, as in Fig. 5. With the contactors in this position the motor is connected to the low-voltage taps of the auto-transformer.

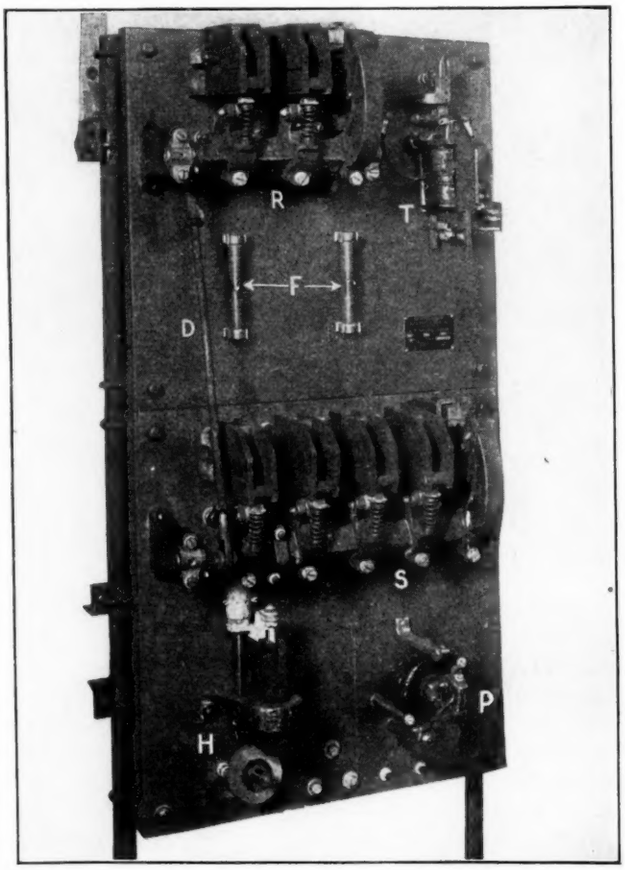


FIG. 1. AUTOMATIC STARTER FOR SQUIRREL-CAGE TYPE INDUCTION MOTOR

Contactor A on the four-pole switch is connected to terminal A_2 at the center of one leg of the auto-transformer. This connection gives 65 per cent. normal voltage at the motor terminals at starting. Connecting terminal A on the switch to A_4 or the auto-transformer will give a higher voltage, while connecting to A_2 will give a lower starting voltage at the motor terminal.

The circuit to the A leg of the auto-transformer is from L_1 on the line switch down to L_1 contactor on the four-pole switch S; from here to terminal A_3 on the auto-transformer through the transformer to A_4, then

to the accelerating relay coil H to contact A on switch S and down to the A terminal on the motor; through one phase of the stator winding to A_1 terminal and up to L_3 terminal on the controller to the L_3 pole of the line switch. Current flowing through section A_3-A_2 of the auto-starter induces an opposing voltage in section A_3-A_1. This opposing voltage causes a secondary current to flow from A_2 through the motor as did the primary current, but instead of passing from L_3 terminal on the controller to the line switch, this current takes the path from L_3 to A_1 on the auto-transformer, thus completing the secondary circuit as indicated by the arrowheads. The circuits for the B phase may be traced out in the same way and are indicated by arrowheads. Accelerating relay H is adjusted so that the inrush current when the motor is first connected to the line holds contact 2-L_3 open, but as the motor increases in speed and the current through coil H decreases, its strength decreases to a point where the contactor is allowed to drop and establish a circuit between points 2 and L_3. This completes the circuit for the transfer-relay coil T.

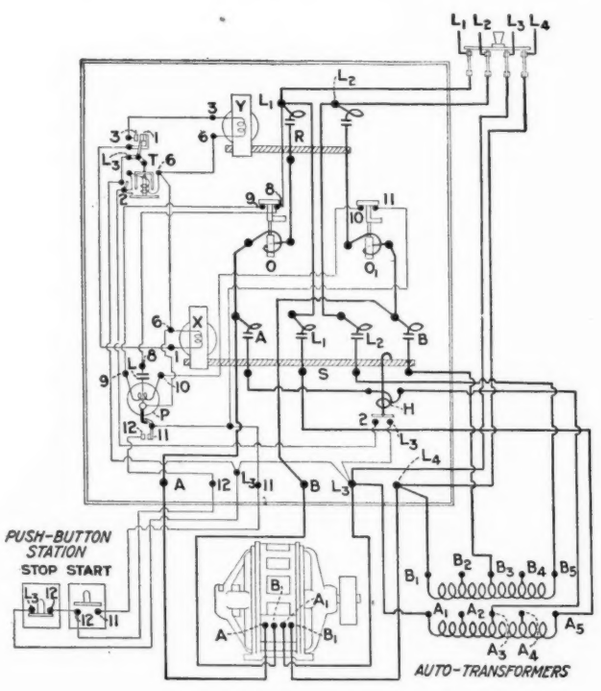


FIG. 2

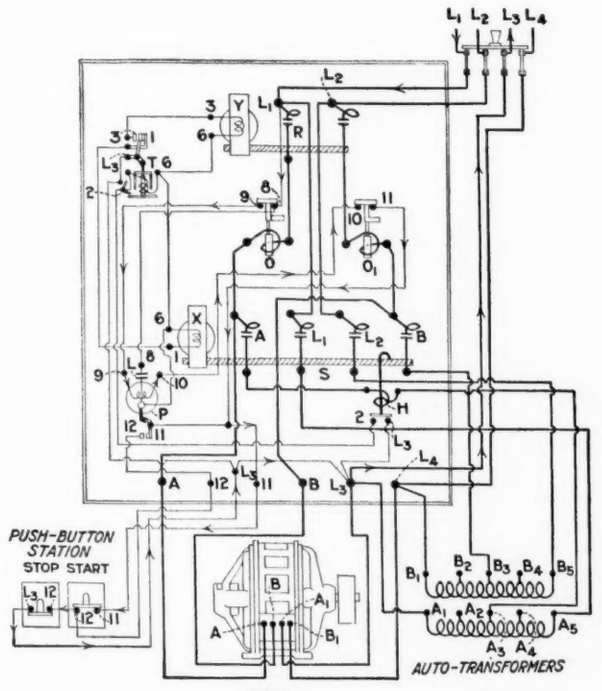


FIG. 3

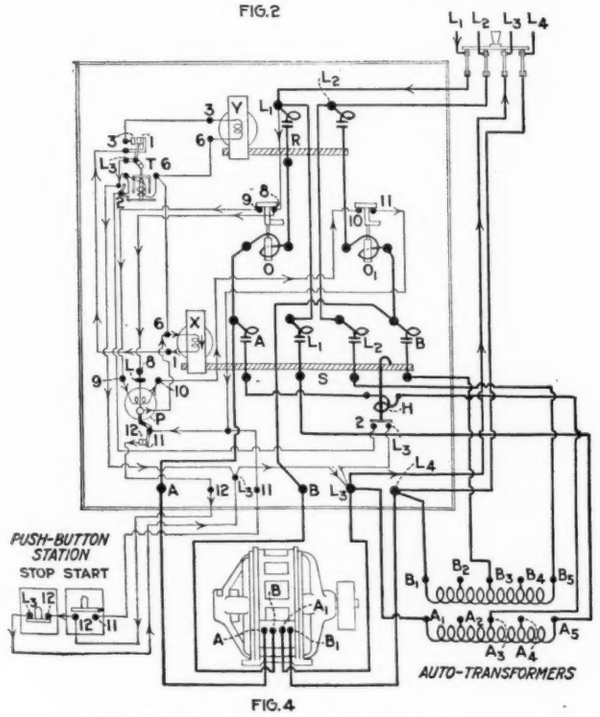


FIG. 4

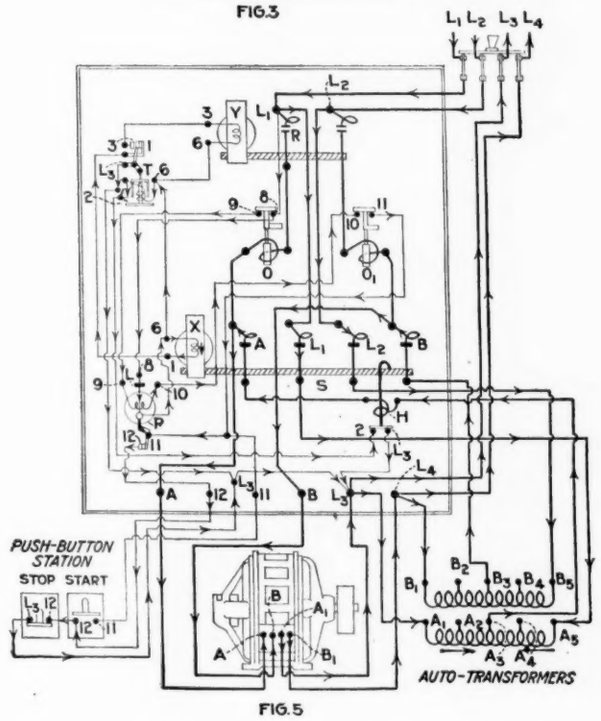


FIG. 5

FIGS. 2 TO 5. WIRING DIAGRAMS OF CONNECTIONS FOR THE CONTROLLER, FIG. 1, IN DIFFERENT STAGES OF STARTING A TWO-PHASE, SQUIRREL-CAGE TYPE MOTOR

The circuit for relay coil T is from terminal 6 on the coil X, through the coil on relay T to terminal 2 on the relay down to 2 on relay H, to the L_3 terminal of the line switch. The operating coil on the transfer relay T being energized, draws up its core and makes contact at point 2 at the bottom and opens contact 1 at the top, and closes contact 3, as shown in Fig. 6. Closing point 2 creates a direct circuit for the transfer-relay coil from 6 on coil X to 6 on the transfer-relay coil, to contact 2 up through the core to terminal L_3 and down around to the L_4 terminal on the line switch. This establishes a holding circuit for the transfer-relay coil and shunts out relay contacts 2-L_3 on relay H, so that their opening when the four-pole contactor switch S opens will not interfere with the operation of the transfer relay.

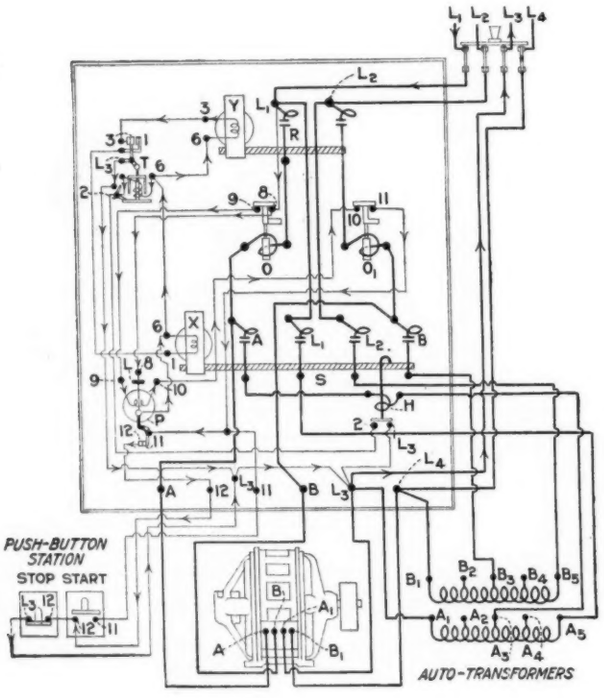


FIG. 6

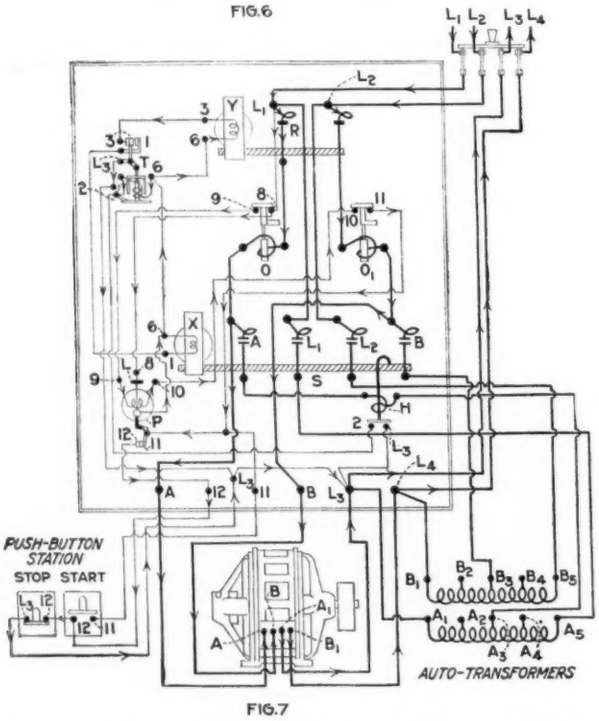


FIG. 7

FIGS. 6 AND 7. CONTINUATION OF WIRING DIAGRAMS OF CONTROLLER CONNECTIONS, FIGS. 2 TO 5

Opening contact 1 on the transfer relay interrupts the circuit of coil X on switch S and allows the switch to fall open, as shown in Fig. 6. The closure of contact 3 on the transfer relay T establishes the circuit for the operating coil Y on the two-pole switch R. This circuit is from terminal 6 on the transfer-relay coil over through coil Y around to terminal L_3 on the transfer relay, and to the L_3 terminal of the line switch. This circuit causes the two-pole contactor switch R to close, as in Fig. 7, and connects the motor directly to the line. The circuit through the motor is from L_1 on the line switch down through A phase of the motor and back to L_3 on the line switch, and from L_2 down through the B phase of the stator winding back to L_1 on the line switch, as indicated by the arrowheads.

Since the circuit of the transfer-relay coil T and operating coil of the two-pole contactor switch R passes through the no-voltage relay P it will be seen that the opening of the no-voltage protection relay P will break the circuit, allowing the two-pole contactor switch and the transfer relay to open and remain open as in Fig. 2, until the start button is again pressed.

The pressing of the push-button marked stop breaks the circuit through the no-voltage protection-relay coil, allowing this relay to open, thus breaking the coil circuit of transfer relay T and switch R, allowing the latter to open and stop the motor. It will also be seen that the operation of either of the overload relays O and O_1 will open the circuit that holds the no-voltage protection relay closed, thus opening the circuit through the coil of the main two-pole switch R.

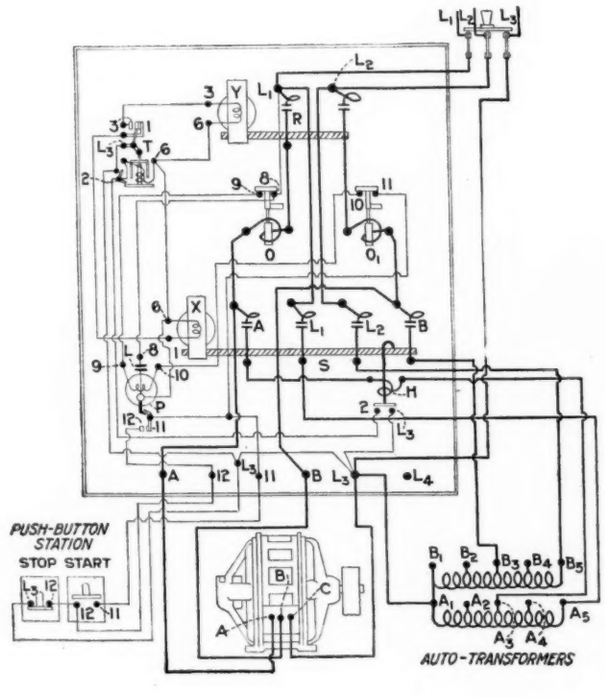


FIG. 8. WIRING DIAGRAM OF CONTROLLER, FIG. 1, CONNECTED TO A THREE-PHASE MOTOR

In general, the operation of the automatic auto-starter is the same for either two- or three-phase motors, Fig. 8 shows the connection for a three-phase motor. The principal difference is in the connections; in the case of the three-phase panel line L_3 is used to replace the line marked L_3 and L_4 in the two-phase diagram.

The two contactor switches are mechanically interlocked by the rod *D*, Fig. 1, so that it is impossible for both switches to be closed at the same time. With one type of this controller without the no-voltage protection relay *P*, in case of failure of voltage, the switches automatically open and upon return of the voltage will automatically close again in their proper sequence. This is termed "no-voltage release," and it is satisfactory to use a controller of this kind with a motor driving a centrifugal pump, air compressor, fan or blower. However, on a motor driving a machine tool or a woodworking machine, where unexpected starting up of the tool would render possible injury to the workmen, the controller is equipped with the additional relay *P*, shown in the lower right-hand corner of the panel, Fig. 1, which prevents the switches from closing upon return of power until the master switch or a push-button station is again closed. A controller equipped with this relay is termed as having no-voltage protection.

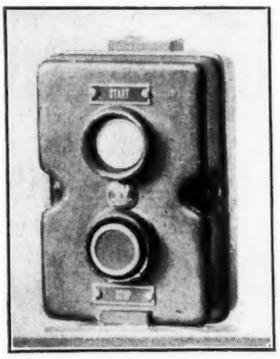


FIG. 9. PUSH-BUTTON STATION

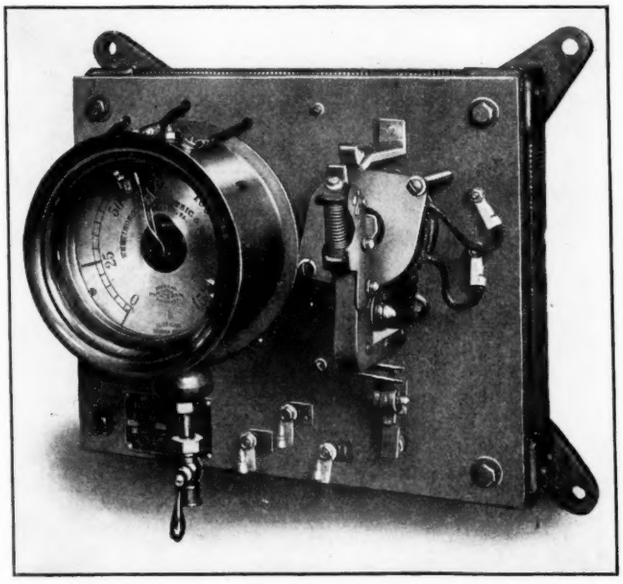
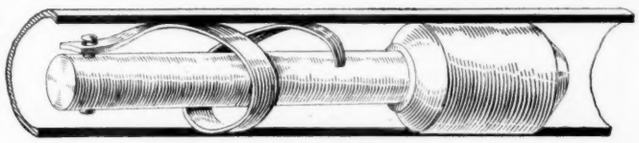


FIG. 10. PRESSURE-GAGE MASTER SWITCH

These controllers may be operated by hand by "start" and "stop" push-buttons, Fig. 9, or automatically by a float-type switch or a pressure-type master switch, Fig. 10. The float-type switch is used in liquid tanks, and the motor is started when the level falls to a certain point and is again automatically stopped at the desired upper level. The pressure-gage master switch is used with a motor driving a compressor or pump emptying into a closed pressure system. The switch makes the connection to start the motor when the pressure falls to a predetermined point and stops it when the desired pressure is reached.

Griffin Condenser-Tube Cleaner

Cleaning condenser tubes is not agreeable work, and with many of the methods employed, considerable time and labor are spent in cleaning them. Several devices for doing this work have recently been described in *Power*. The latest one that comes to our attention is illustrated herewith, and it has been devised by C. M. Griffin, 114 Spruce St., Newburgh, N. Y.



CLEANER IN CONDENSER TUBE

The tool is designed to clean condenser tubes by being forced through them by water pressure of about 100 lb. per sq.in. Its scraper blade is loosely attached to the front end of a central bar, and is tempered and ground to fit the tube, the size depending upon the tension desired. The head or piston at the rear end of the bar is made about 0.04 in. smaller than the tube. The scraper is made with clearance and rake, and retains a sharp edge while being used. Each tool will clean 1000 or more tubes before it is worn out. It is not necessary to provide protection for the tool while being used, and it may be shot against the head of the condenser and dropped to the bottom of the water box without damage.

Although it is not intended that the tool shall revolve by going through the tube, it does make three or four revolutions in passing through an 18-ft. tube, which requires about 3 sec. time, and with 20 or 30 tools at work, two men can clean about 200 condenser tubes per hour.

Automatic Damper Regulation

BY C. A. MORRIS

We may put a force in motion and with a fixed degree of control operate it within a given range and with maximum efficiency, but if the use of this force is not required at the maximum all the time, yet still must be held in readiness to meet any demand within the range governed, then I believe it is necessary to have some method of automatic regulation in order that maximum efficiency may be maintained. If the mind and hand of man through the medium of the eye are depended upon for proper regulation, it is better than no regulation, but a mechanism that will act automatically and at a point not discernible to human senses, it seems to me, will be more efficient and less exacting on the attention of the men in charge of the actual operation of the equipment.

When boilers are operating at a high point of rating against a load that is constantly swinging, frequently as

much as 80 per cent., the judgment and action of the human element are inadequate to obtain the highest efficiency, and in this day of conservation we should put the accent on efficiency—not alone for pecuniary benefit to ourselves, but to help in a national crisis.

We have a station rated at 10,000 kw. with 4000 hp. in normal rating of boilers. The boilers are the Stirling type, eight in number. Two are in disuse owing to

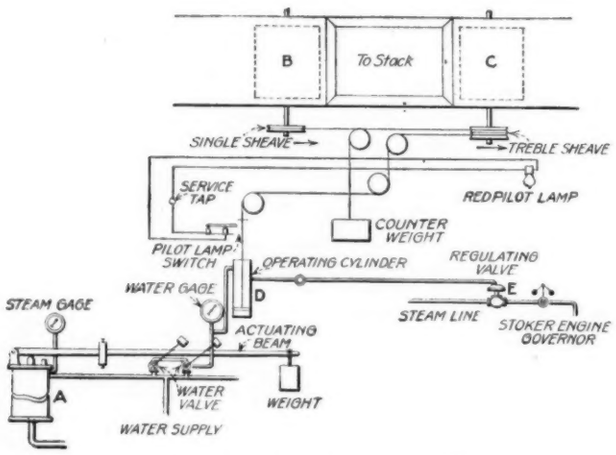


DIAGRAM OF DAMPER CONTROL

the fact that they are equipped with a type of stoker that is not efficient with the kind of coal we use. The other six boilers are served with chain-grate stokers that are driven from a lineshaft by a small engine. It is necessary to operate these boilers constantly at 175 per cent. of rating, and on peak periods they carry 225 per cent., using Indiana screenings and mine-run coal. Steam pressure is carried at 195 lb., with 100 deg. of superheat. Our load is divided about equally between commercial and railway power.

About four years ago the question of higher efficiency in the boiler room was under consideration at our plant, and we installed a system of automatic control of the draft and stokers that has given us continued satisfaction up to the present time at a total maintenance expense of about $12, and we have every reason to believe that it will render good service for years to come. Owing to the finer degree of regulation we were able to secure with this system of automatic control over our old method, our boiler rating was increased with a saving of about 14 per cent. in fuel. The variation of steam pressure was reduced from 20 to 5 lb., and the average CO_2 was increased materially. The boilers now require less cleaning inside and out owing to more complete burning of the coal and to the rapid circulation of the water, and the general expense on the upkeep of our furnaces has been lessened.

Our regulating system consists of a damper regulator *A* attached to two master dampers *B* and *C*, each 10 x 5 ft., which operate vertically in rectangular smoke breechings, one on either side of the chimney, which is 12 ft. in diameter and 225 ft. high. The regulator is actuated by the steam pressure, and the actuating beam releases a water pressure which, acting in a cylinder *D*, closes the two master dampers to the desired point within 30 sec. Simultaneously with the action of the water in the cylinder, the same pressure is transmitted to a special regulating valve *E* on the stoker-engine steam pipe, so that the speed of the stoker is cut to a point in relation to the closing of the dampers, and after hours of operation the fires are maintained at the proper thickness and length without manual effort. It is this particular feature of the equipment that distinctively places it in the efficient class. The design and connections of the master dampers are such that any desired degree of operation can be secured and also the stoker valve can be so adjusted as to be always in true relation to the operation of the dampers.

One of the most important features in connection with this system is a red signal lamp, which is suspended centrally in the boiler room. This signal is flashed the instant the regulator goes into action and remains burning until the dampers are closed again. This lamp is to the firemen what the compass is to the sailor, and without it the system would lose a great deal of its value. Should the light remain on more than two minutes at any period, it denotes that something is interfering with the boilers in meeting the demand for power. The flow meters will indicate whether it is an increase in load or not; if the load is regular, there has been a change in fuel and the proper adjustment is made on the stokers. Low steam pressure permits water pressure to open the dampers, and as soon as the normal steam pressure is regained, the dampers are released from the water-pressure cylinder and counterweights close the dampers.

With the increased load the plant now carries over that which it carried previous to this installation, three boilers in full operation meet all demands, the fourth being used as a buffer. Previous to the installation of the regulator four boilers were required at high service, with the fifth as a buffer. The initial cost of the regulator was met by the fuel saving effected during the trial period.

J. R. S. Low-Grade Fuel Burner

In these days of high-priced fuel and coal shortage throughout the country, manufacturers are turning their attention to perfecting devices that will burn the

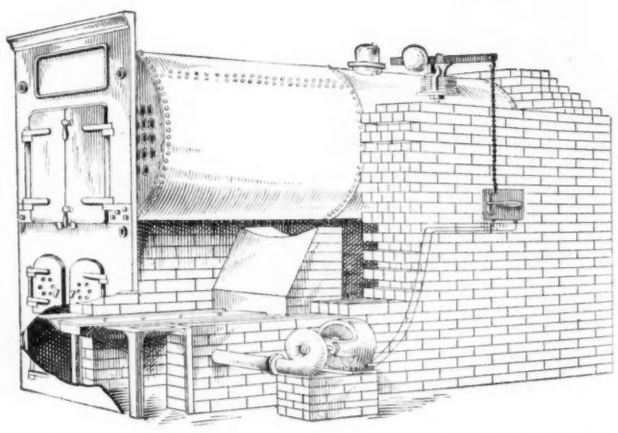


FIG. 1. BURNER AND DRAFT FAN AS APPLIED TO FURNACE

lower grades of fuel. Among others who have been working on the problem is the Mechanicville Specialty Supply Manufacturing Co., Mechanicville, N. Y., which is manufacturing the J. R. S. Low-Grade Fuel Burner. The object of this apparatus (Fig. 1) is to burn such

low-grade fuels as coal dust, screenings and buckwheat, both anthracite and bituminous coal, and especially such grades as cannot be burned with natural draft.

The burner is made of cast iron, as are also the "filling-plates." Two burners are usually placed in a furnace, the "fillers" being bolted to them. The burners are spaced so that about half of the width of the furnace is between them, and midway is an ash dump so constructed that it is practically gas-tight when closed. The design of the burner and also the ash dump is shown in Fig. 2.

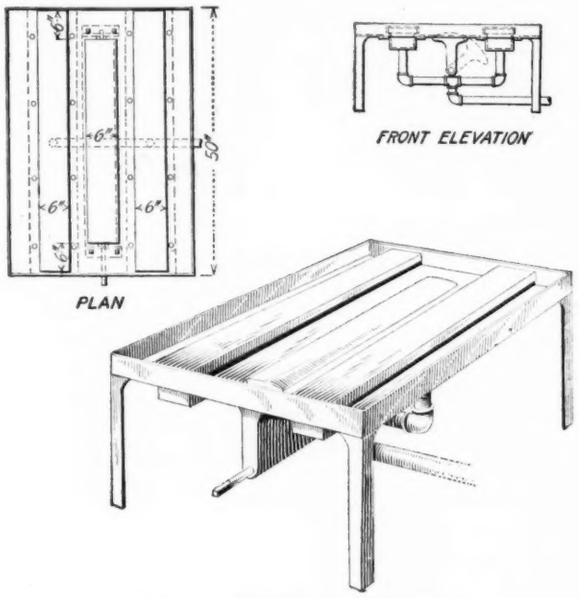


FIG. 2. DETAILS OF BURNER

No grates are used, and the edges of the burners, where they come against the brickwork, are sealed with a noncombustible substance so as to prevent the flow of air from the ashpit into the furnace.

Each burner consists of an air-box over which is a cover plate so separated from the box body proper that there is from $\frac{1}{2}$ to $\frac{5}{8}$ in. opening between them on the sides. In other words, the design is about what would be obtained with an ordinary cardboard shoe box with the cover a couple of sizes too large for it and lifted about one-half inch from the body. Air is supplied to the burner through a bottom connection, as shown. In the case of a double burner the air connection is made as indicated by the elevation in Fig. 2.

The discharge of air from the burner box is underneath the cover plate and along the two sides in a semilateral flow downward, and rebounding under a pressure at the points of discharge into the coal, it is distributed to the fuel surrounding the burner. The air pressure can be carried as high as 12 in. of water, thus enabling the operator to carry a heavy fire as is frequently necessary in plants that are operated at their full capacity. With a clean fire the draft would, of course, be much less than would be necessary with a heavy, dirty fire.

Air is supplied by means of either a direct-connected motor-driven or a belt-driven fan. The operation of the motor is controlled by a diaphragm-pressure regulator. For instance, if the damper regulator is set to control the steam pressure at 100 lb., the motor and blower will supply air to the fire until the steam pressure reaches that point. The diaphragm regulator then operates a switch and shuts down the motor. A drop in the steam pressure causes the regulator to throw the switch again to start the motor.

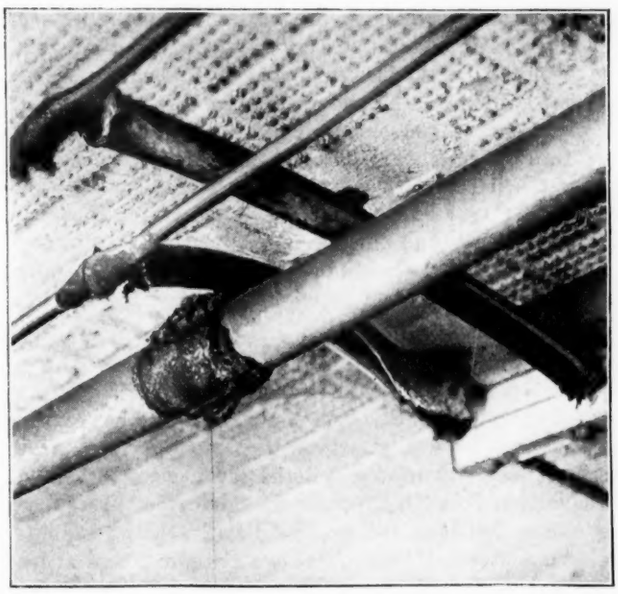
The fuel is fired as with the ordinary grate furnace, and the ashes are discharged into the ashpit through the dumping gate.

Lighting Circuit Caused Water-Pipe Joint To Corrode

BY B. A. BRIGGS

The effects of eddy currents, produced by stray magnetic fields set up by alternating-current circuits, are probably not appreciated as much as they should be. The illustration is an example of what may happen to a pipe coupling where an alternating-current lighting circuit is installed near it. This installation is in a perfectly dry basement that is heated in the winter. The pipe line, which is used for water supply to the building, is only a few inches away from a ceiling covered with plaster boards.

The electric installation has been in use for a period of only about three years; previous to that time the joint was not corroded, neither has any other pipe joint, either gas or water, corroded in the building since the electric circuits were installed. Therefore it appears to be quite evident that the presence of the electric circuit at the pipe joint caused the corrosion. The corrosion had gone so far when this photograph was taken that in some places the threads of the coupling were visible.



ELECTRIC WIRING AND PIPE JOINT

[Although the foregoing is not positive proof that the presence of the lighting circuit caused the coupling to corrode, nevertheless it brings up the question as to the advisability of running electric circuits across a pipe coupling as in the figure. *Power* would appreciate an expression of opinion from interested readers for publication on the foregoing question.—Editor.]

Buying an Ash-Handling System

By HERBERT E. BIRCH

How to intelligently purchase an ash-handling system to remove ashes from boiler ashpits is a question that is confronting many engineers and is discussed here. It is a timely subject, and there are many ways of solving this apparently simple problem.

TO ONE who is not thoroughly familiar with the effect of ashes on conveying machinery, it seems like a waste of time to give the subject much consideration, but it requires more thought to design or purchase ash-handling equipment than it does a system to convey coal. Any conveyor to handle coal may be installed with reasonable expectations of a minimum upkeep cost, but with ashes it is necessary to proceed cautiously, for there are many points that demand consideration.

Perhaps the first one is whether to install a single conveyor to handle both coal and ashes. The claim in favor of this method is that it avoids a multiplication of machines and driving parts and so reduces the cost of operation and maintenance. Against this, there are the claims of those who prefer a "divorced" system, where the ashes are handled in a conveyor set apart for that purpose only. Briefly, these are that it is often necessary to handle coal and ashes simultaneously, which it is impossible to do with the "one for all" conveyor; that the equipment runs only about one-tenth of the total time to handle ashes, and that it is subject to the wear of the ash grit in the chain joints the remaining nine-tenths; that wet ashes sometimes pack in the buckets and they have to be cleaned out before coal can be handled, and that inasmuch as the conveyor was made heavy and ponderous to resist the destructive effect of ashes, it is foolish to pull this extra load around the boiler room when handling coal.

Most Engineering Firms Prefer "Divorced" System

These points must be carefully weighed before deciding which system to follow, but in this connection it may be well to state that most of the large engineering firms prefer and the large New York and Philadelphia boiler houses use the "divorced" system.

Assume that it is decided to follow in their footsteps and see just what there is to watch and where there is a probability of being tripped up by the salesmen who present for consideration the various systems on the market. Perhaps the best way to do this is to first look at the ashes—examine their make-up. It is well known how destructive a few grains of grit in a bearing would be. The ashes may be dripping wet, red-hot, dry and dusty, or hard with sharp corners, but they are never just plain ashes.

All of this suggests abrasion. Consider first what effect they will have on the system that is being investigated. Are there any chain joints or other moving parts that are likely to wear out? Perhaps there are no chains. Then do the ashes move in, over, or through anything? It does not make much difference whether they move and the part that wears out is stationary, or whether the ashes are stationary with respect to the moving part; wear occurs in any event, and the result is that the repair bill is high or, as often happens, the outfit is thrown out by someone higher up.

Power requirements often lead to the rejection of a conveying system, for power costs money. Will the apparatus under consideration consume much power? Will it use power at its maximum rate all the while it is in operation, or does it consume energy only while it is actually conveying its full load? Some systems operate under full power while the ashman is lighting his pipe or while it is conveying only at one-half its maximum capacity. Is the power consumption so large that it is necessary to keep 90 or 100 hp. continually floating on the line ready for ash-handling service at any instant? One argument for large power-consuming devices is that ashes are handled only when there is a large head of steam on that would be wasted anyway. Beware, for it is but a snare and a delusion. What is the intelligent engineer doing with so much steam to waste?

Breaking the Clinkers

What size clinkers do the stokers make? Perhaps they are working under an overload and the clinkers are extremely hard. Must these clinkers be broken into small pieces before they can be fed into the conveyor, or can they be put in just as they come from the furnace? Do not let anyone minimize this point by suggesting that it is easy to put a concrete block at each conveyor intake upon which to break any recalcitrant clinker; plant operators are not in the butcher business.

Frequently it is desirable to get rid of boiler-room refuse by means of the ash conveyor. Will it handle firebrick, flue dust, soot, etc.? Do not take the salesman's say-so. Investigate, use common sense and find out.

How about dust prevention? Maybe the plant is at a textile or paper mill, where dust is frowned upon. Will the conveyor under consideration handle a finely powdered material and deliver it to the ash bin without kicking up a cloud of dust? If it will not, can it be wet and then will the conveyor handle it? Will the putty-like mass that is formed clog up the system and will it be necessary to poke it out in order to start the apparatus working again? Or, if it is handled dry and quenched just before it is discharged into the ash bin, is the quenching system subject to freezing in winter? Possibly, where steam is used as the propelling agent, mud will be produced, which is apt to cause trouble at the turns. Consider what happens to the ashes (or mud) in the conveyor when it stops handling them. Is it necessary to poke things clear before it is possible to start up next time? Is the mud likely to settle at the lowest point and cake there, and if it does, how easy is it to find where this occurs?

How about a dirty appearance around your plant? Will it be necessary to drop the ashes from the stoker

hoppers and then rake them into the conveyor? An ashman is not apt to be overly clean in sweeping up after he is through, but can he be blamed?

How about safety? Some systems explode occasionally, doing severe property damage. See *Power*, page 468, Apr. 3, 1917. In this accident two men were killed.

The capacity of the system should be of interest also. It is possible that it will take several men to tease the ashes through an intake opening in order to handle the amount that is made. Then there is the distance the system will convey the ashes and the height to which it will lift them. Perhaps if there is a long run in the basement and a good high lift, the power consumption will be enormous.

Noise a Factor To Be Considered

Another factor that may influence judgment is the noise the apparatus is likely to make. Some conveyors emit a grinding noise which is extremely disagreeable to those who live close by. At several plants, the municipal authorities prohibit the conveyor working at night, and at least one, to my knowledge, was refused permission to operate on the ground that it was a common nuisance.

Will the proposed installation meet the exacting demands of the *OMIA* formula? This means that operating charges *O* plus maintenance charges *M* plus interest on the total money invested *I* plus the adaptability *A* of the plant (which can hardly be measured in dollars) must be less than the labor saving effected. Operating cost includes power, labor to operate, oil and such incidentals. Maintenance charges include all repairs of any nature whatever and the labor expended in making these repairs. Under this head is usually included depreciation, which is likely to be high in an ash-handling plant. Conveying-machinery depreciation is figured at 10 per cent., but in some types of ash conveyors, where no machinery is used, the depreciation is likely to be 30 or 40 per cent.

Interest on the investment includes not only the interest on the parts purchased from the manufacturer, but on the cost of labor to install, foundations, and any preparatory work that may have to be done, bunkers built, etc.

Operating Costs

Just a word in passing from this phase to the next. Do not be fooled by the oft-repeated statements of "a few cents per ton to handle ashes." Just figure it out. At 30c. an hour for labor, if 5 tons of ashes are handled per hour with the system, that is 6c. per ton for labor alone. How about power, which is apt to cost 20c. per ton in some systems? The cost per ton to handle ashes is determined by dividing the *OMI* cost per year by the tons of ashes handled. If an ash-handling system is already being operated, sit down right now and figure it out, but be prepared in advance for a big surprise. Instead of 6c. per ton it is more likely to be 30 to 40c. Then perhaps one will wonder just what is the trouble with a wheelbarrow, which has no operating difficulties, interest, maintenance and other charges to speak of. It may be that if an "educated wheelbarrow," with ball bearings and four wheels running on tracks is used, it would prove to be just about the right thing. There will be use for a man anyway, so why not let him push the wheelbarrow?

Speaking of having to have a man is a reminder that there is an opportunity to say just a little about the design of ash hoppers. If the plant runs night and day, the ash hoppers ought to be large enough to take care of the accumulation of ashes during the night and thus avoid a night shift of ashmen. The best condition is where all the ashes can be handled by one shift. It would probably be advisable to figure out how much labor would be saved by rearranging the ash hoppers to accomplish this, and determine what could be spent to do the job. Roughly, an expenditure of about $2200 is warranted for every dollar per day saved.

The engineer who spends his time thinking of such problems as this is the one who grows. Such a man cannot be kept down. Let someone else polish the brasses, or else do away with them, for if a man thinks and acts in such small terms, then surely will the real job, the job worthy of an engineer, be taken from him.

Ash-Handling Methods That May Be Used

Now to get back to ash conveyors. The following methods may be used to handle ashes:

1. By vacuum systems, which are divided into two classes: (a) Complete vacuum systems, where the vacuum is maintained by exhausting the air from the ash bin; (b) partial vacuum, where the jet of steam creates a vacuum in the conveyor pipe back of the jet, but where the jet itself has a positive action on the ashes ahead of it.

2. Ash drag in a trench in front of the boilers or in a tunnel beneath the ash hoppers. This drag consists of a wide malleable chain running in a cast-iron trough and dragging the ashes with it. It may discharge to another drag conveyor which operates on an incline, or it may discharge to a:

3. Bucket elevator of the centrifugal discharge type, which is usually vertical or but slightly inclined. This bucket elevator may be used in connection with wheelbarrows or a push car.

4. Ashes skip hoist, which consists of a large bucket that runs up steel guides and dumps into an ash bin. This system is usually arranged so that the operator pushes a button and the bucket full of ashes ascends, dumps, reverses and descends automatically, coming to a stop in the loading pit. This skip hoist can operate in a vertical path or on an incline of, say, 45 deg., or anything between these two conditions. The skip bucket may be filled by means of a push car, wheelbarrow or ash drag. In the last case, it becomes necessary to provide an equalizing hopper to take care of the ashes which accumulate while the skip bucket is hoisting a load. (This is always necessary where a continuous conveyor delivers to an intermittent one.)

5. A grab bucket operated by a monorail crane may be used to dig ashes out of a pit where they have been discharged, by barrow, push car, steam jet or ash drag. The pit is then made large enough to take care of storage, thus eliminating the overhead bunker. However, an experienced man is usually required to operate a grab-bucket crane, which is one disadvantage of handling ashes in this way.

6. Cold ashes can be handled on a belt conveyor, but if the clinkers are large the belt must be wide, say 36 in. for large clinkers, unless they can be broken.

This applies to several of the other types of conveyors, where the clinkers have to be broken before they can be teased through a 6-in. hole.

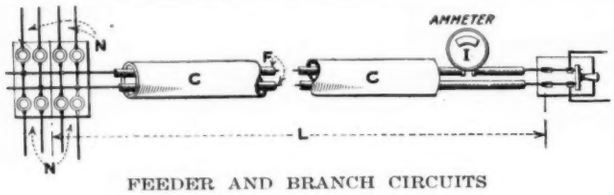
The foregoing are the principal methods used, and although others may exist, they are of minor importance. Even No. 6 could be omitted, but was mentioned to bring out the point about the clinkers.

Get acquainted with the various methods, applying to each the points mentioned in this article and then you will be in an excellent position to recommend the type of equipment to buy. The boss will not be in a mood to accept excuses when it becomes necessary to throw out a bad investment, but you will never be in this position if a little study is given to the subject now.

Conduit and Wire Sizes for Two-Wire Feeders

By T. A. Nash

A table showing what size conductors will be required to carry different numbers of 660-watt branch circuits with a 2 per cent. or a 3 per cent. drop is given herewith. The first column indicates the number of 660-watt circuits in each case. The second column, headed "Amperes," indicates the approximate number of amperes in each case, and the third column shows the smallest size of wire that can be used for the feeder without excessive heating of the wire. The fourth column indicates the normal size of conduit that can be used, assuming double-braided, rubber-covered wires are installed. The fifth and sixth columns indicate respectively the maximum distances to which the currents indicated in column *I* can be carried in the wire size of column *F* with a 2 per cent. drop and with a 3 per cent. drop. An indication of what the table stands for in the circuit is given in the figure; the letters at the top of the columns correspond to those on the illustration.



FEEDER AND BRANCH CIRCUITS

TABLE SHOWING FEEDER AND CONDUIT SIZES FOR 110-VOLT TWO-WIRE SYSTEM

N	I	F	C	L	L
Number of 660-Watt Circuits	Amperes	Size of Feeder	Size of Conduit for Rubber-Covered Wire	Extreme Distance for 2 per Cent. Drop	Extreme Distance for 3 per Cent. Drop
3	18	12	½	37	55
4	24	10	½	44	66
5	30	8	¾	57	85
8	48	6	1	56	84
11	66	4	1¼	64	97
15	90	2	1¼	76	114
16	96	1	1½	89	134
20	120	0	1½	90	135
25	150	00	1½	91	136
29	174	000	2	99	148
37	222	0000	2	98	146
39	234	250,000	2½	110	165
45	270	300,000	2½	114	171
50	300	350,000	2½	120	180
54	324	400,000	3	127	190
60	360	450,000	3	128	192
66	396	500,000	3	130	194
70	420	550,000	3	135	202
75	450	600,000	3	137	205
79	474	650,000	3	141	211
83	498	700,000	3	144	216
87	522	750,000	3	147	221
91	546	800,000	3½	150	225
95	570	850,000	3½	153	229
100	600	900,000	3½	154	231

Operating Costs of Electric Elevators

By Charles W. Naylor

Chief Engineer, Marshall Field & Co., Chicago; Member A. S. M. E.

The electric passenger elevator has now been in service for a period long enough to enable the engineer to report intelligently on its cost of operation, maintenance and repair. Hitherto, reports on electric-elevator costs have been in a great measure based on tests made at the time of, or very soon after, installation, and the real cost, such as could be shown only by records of years of operation, has in the main been a matter of conjecture. The repair or maintenance side of the ledger, in which cost records are tabulated, shows a marked increase as the machine becomes older, after making due allowance for the advance in the cost price or repairs, which is now so noticeable.

This article will be based on the records for ten years, ended Dec. 31, 1916, for 50 worm-gear, drum-type elevators having a 150- to 230-ft. lift and running in passenger service at a maximum speed, loaded, of 350 ft. per min. The elevators cited are all in one building, operated in a similar manner, doing exactly the same kind of work for equal numbers of hours per day, and cared for by the same set of mechanics, using the same oils, grease, cables, ropes, brushes, etc.

They are all of the overhead drum type, as shown in the figure, overbalanced as to counterweight and equipped with all the standard accessories that go with this make of elevator. They are operated on direct current at about 226 to 230 volts, with magnet control of the usual construction and steel guide rails for cars and counterweights. There are two sets of counterweights, one for the drum and one for the car. All cables are standard, ¾ in. diameter, running over idler sheaves and drums of approximately 46 in. diameter. The car-counterweight cables, two in number, pass directly over the vibrating or idler sheave *A*, while the car-hoisting cables wind on the drum *B* as the drum-counterweight cables unwind, and vice versa.

There are no equalizing or compensating cables or chains. The cars, or cages, of a rather heavy pattern, weigh approximately 4000 lb. each, and the double counterweights about 5000 lb. The drums are driven by double, or fore-and-aft, bronze worm gears meshing with steel worms on an extension of the armature shaft, with the magnet brake installed on this shaft between the armature and the worm. The armature revolves at 850 r.p.m. when on high speed, and the drums make about 30 revolutions during the same period. Of the cars listed, five have a travel, or rise, of 150 ft., forty have 200 ft. and five 220 to 230 feet.

In addition to the overhead type of passenger cars, there are five machines of the basement type, the driving mechanism being at the lower landing, with traveling idler sheaves over the drum. The lift is about 40 ft. For the various items shown in the table the operating costs are about the same. The extra cable wear is in a measure compensated for by the shorter length, the cables wearing out in two or three years as against six to ten years for the longer lifts. There are also 11 freight elevators of overhead type, 220 ft. travel, with a somewhat slower speed and smaller motors. These machines cost 10 per cent. less for all items shown in the table, except for cables, and 50 per cent. less for

these. Their speed is 250 ft. per min., and they travel about 6 to 8 miles per day as against 12 to 15 miles each per day for the passenger cars.

The labor shown is for the wages of the maintenance and repair mechanics. Each man cares for 12 cars, oiling, cleaning, adjusting and ordinary repairs. Two extra men care for the heavy and extraordinary repairs such as installing armatures, greasing guides and putting on cables. The increase from year to year is occasioned by some additional help and wages advanced for the old employees.

The item miscellaneous includes leather for brakes, copper rivets, babbitt, bolts, screws, etc. The armature expense is mostly for rewinding and includes a few field-coil renewals. The repair item includes brushes, controller disks, contact lugs, carbons and such material as would naturally be purchased from the manufacturer of the machine, used mostly in keeping up the controller boards. Oil includes engine oil for bearings and guides

MAINTENANCE COSTS OVER 10 YEARS FOR 50 ELECTRIC ELEVATORS *

	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	Total	Average
Oil.....	93	93	93	68	68	110	110	78	92	52	857	86
Grease....	8	16	16	25	26	34	28	29	31	9	222	22
Repairs...	425	1,105	618	465	467	603	119	40	39	96	3,977	398
Armatures	1,060	1,160	461	1,148	935	540	918	580	660	362	7,824	782
Cables....	....	467	188	323	140	174	213	316	360	1,012	3,193	319
Labor.....	5,000	5,000	5,525	5,525	5,525	6,375	6,375	6,450	6,450	7,650	59,875	5,988
Misc.....	110	59	307	238	344	170	269	84	270	92	1,943	194
Total...	6,696	7,900	7,208	7,792	7,505	8,006	8,032	7,577	7,902	9,273	77,891	7,789
Per car..	134	158	145	156	150	160	161	151	158	185	1,558	156

* For simplicity all amounts given to the nearest dollar.

and castor or castor-machine oil for the worm cases. Cables include the $\frac{3}{4}$-in. main cables and the $\frac{1}{2}$-in. wire and $\frac{5}{8}$-in. manila rope for the governors.

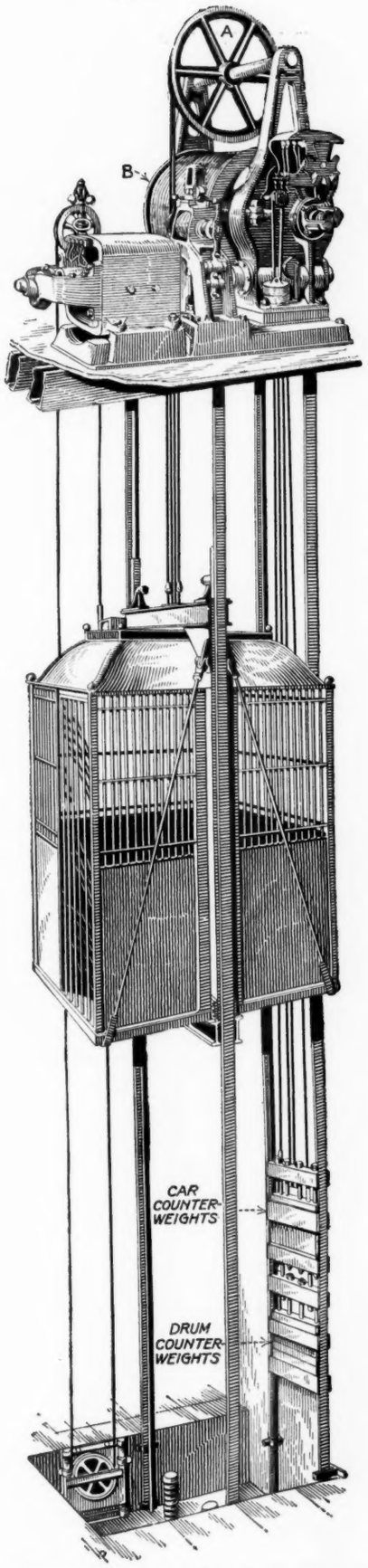
Each passenger car travels about 13 miles per day, and for the year of 310 days, totals 4030 miles. Dividing the average annual cost per car by this mileage gives a maintenance cost of $0.0387 per car mile, of which about 75 per cent. is for labor and 25 per cent. for materials and supplies.

In the same plant are 11 worm-gear one-to-one traction machines having 230 ft. rise in the hatchway, with compensating chains. The cars travel 375 ft. per min., or 14 to 16 miles per day. Maintenance costs at present are about the same as for the old drum types, except for cables, which wear out about twice as fast as they do on the drum machines. These elevators are now only three years old, and it is too early to pass upon their real cost of operation.

There are also five basement worm-gear one-to-one traction machines with compensating cables, having 140 ft. lift and a speed of 300 ft. per min. The ropes on these machines wear out very rapidly.

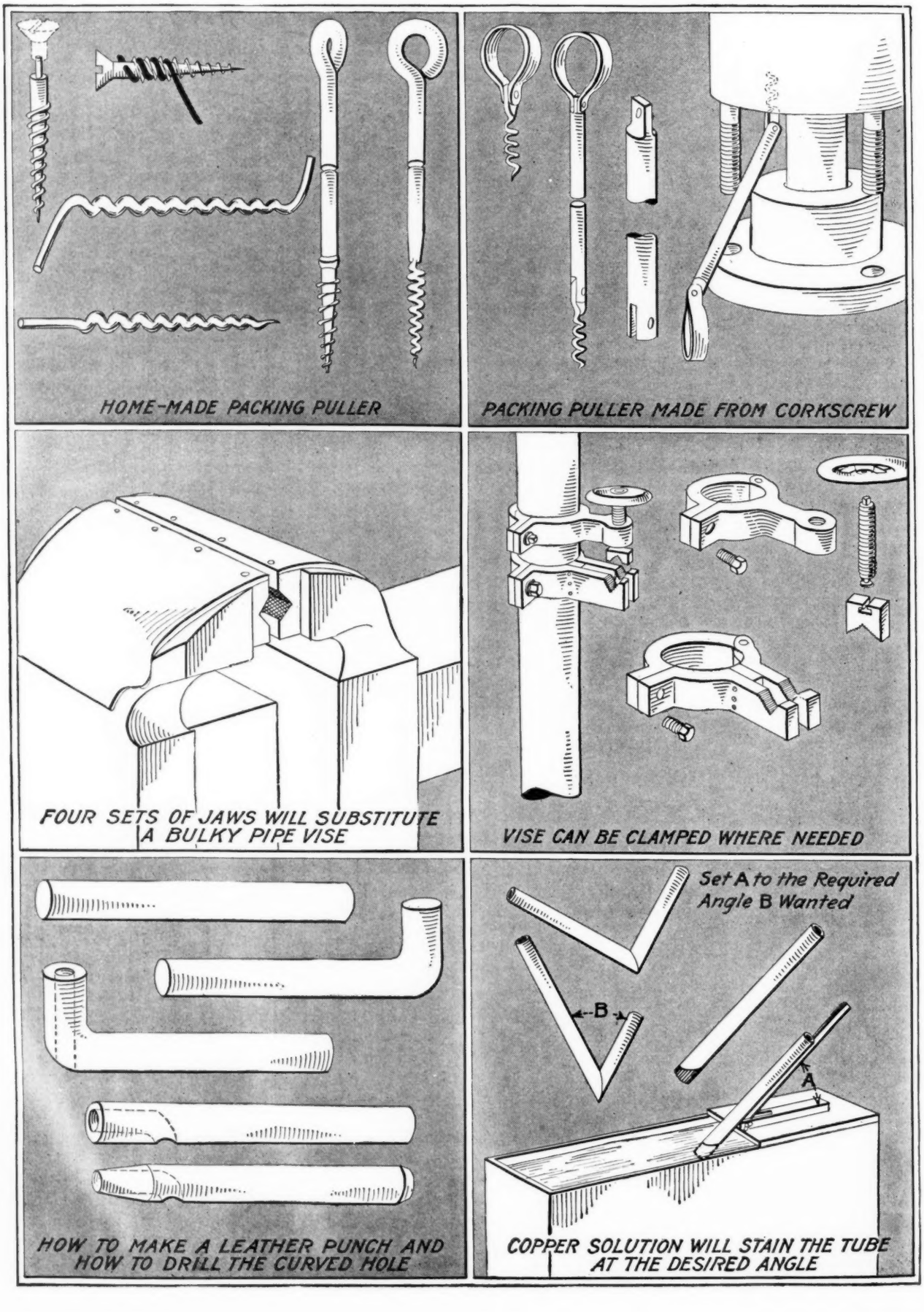
In addition to the foregoing there are eight one-to-one overhead traction machines having 280 ft. lift, 450 ft. speed and equipped with compensating cables and weights. The cars travel about 20 miles per day each, and the cables are wearing out three times as rapidly as those on the old drum machines. These cars having been in use only three years, it is wisdom to defer decision on their operating cost to a later date.

In the plant there are 77 passenger and 14 freight elevators traveling about 1500 miles and carrying from 150,000 to 325,000 passengers per day. The cost per car-mile for current is practically the same for all types. A future article will deal with some of the many operating troubles peculiar to these machines.



OVERHEAD TYPE ELEVATOR MACHINE

Handy Home-Made Apparatus


HOME-MADE PACKING PULLER
PACKING PULLER MADE FROM CORKSCREW
FOUR SETS OF JAWS WILL SUBSTITUTE A BULKY PIPE VISE
VISE CAN BE CLAMPED WHERE NEEDED
HOW TO MAKE A LEATHER PUNCH AND HOW TO DRILL THE CURVED HOLE
Set A to the Required Angle B Wanted
B
A
COPPER SOLUTION WILL STAIN THE TUBE AT THE DESIRED ANGLE

Editorials

The Fuel Administration Mandate

THE practical suspension of business by the Fuel Administration for five days and for a day each week for seven weeks to come, was one of the largest exercises of governmental authority to which industry has ever been asked to submit. If it effects its purpose, Fuel Administrator Garfield is entitled to a meed of credit proportional to the magnitude of the exigency and the boldness of the remedial act.

The execution of such a measure can be justified only by the existence of a condition of the utmost gravity; its wisdom can be demonstrated only by the extent to which it is effective in mitigating that condition.

In the first place its primary object was not the saving of fuel, but the slowing up of production. Industries, speeded to the utmost, were piling upon the already overburdened railways, goods for transportation to the seaboard. Ships could not be coaled fast enough to take the goods away. Terminals were congested, cars were held up and the roads and sidings were blocked, interfering with the transportation of the coal needed to relieve the situation. The effect was cumulative. Much as some of the goods were wanted, it was bootless to make them simply to be piled up in the cars which might be hauling coal and which were standing in the way of trains that might relieve the coal famine.

Could the railroads have been speeded up enough to overtake the accumulation and at the same time take care of the daily increase? Those who are in the best position to know say that they could not. Could the manufacture or shipping of nonessentials have been suspended? Several days were lost in proving this to be impracticable. And so, in the light of what they know, and what the man on the street does not know, those responsible for results said, "We must stop and let the roads catch up, or go on from worse to worse." To have announced their intention to do this would have aroused such remonstrance and have set into operation so much machinery of opposition as to render it impossible, and would have so speeded up production in the interim as to further swamp the roads and further deplete the diminished coal supply, to say nothing of its effect upon the market.

It had to come, as it did come, like a bolt out of the blue; and before some of our good people could weigh the petty sacrifice that they were asked to make against the supreme sacrifice that those are making to whose support this order ultimately means the most, there arose a storm of indignant protest, which has subsided at this writing to an attitude of quiescent submission, and which we hope as this is read will have changed to one of intelligent appreciation and approval.

The importance of the fuel supply, even to interests to which it seems but remotely related, has been demonstrated this winter as never before. The orderly conduct of the procurement and distribution of that supply is a matter of the utmost concern to the whole people. The organization of a system for such control out of a mass of competing units, with a crippled railway system, in a winter of unwonted severity, and against the covert opposition of those who do not wish to see the practicability of government control successfully demonstrated, is not the work of a week or of a season. Without the Fuel Administration there would have been a coal shortage fully as acute as the present—for the mines now are turning out all that the roads can haul—and prices would have soared unrestrained.

Let us have patience until the machine gets warmed up. Let us not go into hysterics if it skips a stroke now and then. Back up the Administration until it has a chance to put into effect some of the measures now in view and in development, and this year's condition will be pointed to as an example of those which intelligent organization in the interest of over-all efficiency can correct.

The Day of the Recording Instrument

NOT many years ago the recording instrument in the average plant was a rarity. Its use was considered superfluous, and if perchance an instrument of this type did find its way into a plant, its possibilities were not fully appreciated. Considered more in the light of an ornament, there was no great incentive to maintain it in accurate working order, and more often than not the records would be dumped into a drawer of the engineer's desk or perhaps filed away for safe keeping. Those were the days of cheap fuel when a few tons of coal, one way or the other, was not seriously considered. Conditions were not severe, and the indicating instrument did very well. Plants fully equipped did better than those with no precise measuring instruments, and if the meters were read often enough, the time indicated in each case and plots afterward made, a rough approximation of the register of a recording instrument was obtained.

Securing complete operating data in this way and the subsequent plotting were tasks too arduous for the average operator. More than occasional readings could not be expected. Comparison of the value of data obtained in this way and of time records from accurate instruments recording every variation of the quantity measured and transcribing it so that the range over the entire period may be read at a glance, is not difficult to make. With the proper number of instruments simultaneous records giving complete operating data for the station are at hand ready for analysis, and as the records are permanent, comparison with previous performance is easy.

There is no need, however, of championing the recording instrument. It is already with us. Its merit has been proved, and its adoption even in the smaller plants is becoming more general. The war, the urgent demand for coal, the rise in price and the necessity for efficient

production have been contributing factors. In these days coal must be conserved for military purposes.

The small plant is working on a closer margin than ever before. It must be fortified in every way possible and must conduct its business intelligently, complete and accurate data being the first essential.

Those plants which have been getting along comfortably in the past with incomplete indications of operating conditions, cannot afford to continue in the old way. The recording instrument offers a decided advantage. There has been a big development in this field. More and better instruments than ever before are available. Coal must be saved. A wise selection of meters, showing the operator exactly what is being done in the plant and where improvement is possible, is the first step.

How Do You Mix Your Fuel?

ONE of the most urgent problems that now confront the engineer is the utilization of the lower grades of coal, such for example, as screenings and culm. It has been supposed that the culm piles were pretty well cleaned out, but the fuel shortage has developed that there are great quantities still available and at a price that makes it worth while to attempt burning it when mixed with soft coal.

There immediately arises, then, the problem of mixing the culm or screenings and the soft coal so that when used in stokers the mixture will be sent to the stoker hoppers in such way that there will not be a segregation of the lumps as the fuel goes to the stokers. Should this happen, it is almost impossible to prevent holes in the fire of so serious a nature as to make combustion not only uneconomical, but difficult to carry on. Obviously, the problem is a local one and the conditions in each particular plant will require different measures for its most successful solution.

Engineers are greatly interested to know how the other fellow is doing it, and *Power* extends an invitation to those who have met this problem to tell how they have met it and what troubles they have encountered in mixing the fine, powdery fuel with the run-of-mine coal. What proportions are found most suitable for particular types of stokers with particular settings and for the various loads? In hand-fired plants it is a simple matter to mix the culm with the soft coal, but where crushers are used and where the coal is conveyed to an overhead bunker and then gravitates to the stoker hoppers, it is not so easy to get the best mixture.

It is quite important that engineers learn how to burn culm and other very low-grade fuels, especially those which are byproducts of mining and which, unless used, may stand for years in huge piles exposed to the atmosphere, thereby suffering deterioration in heating value. The sooner such fuels are used after they come from the mines, the greater their value.

Let us know how you get your mixture and how you crush, convey and feed the fuel.

Alaska's Coal

WHEN Secretary Seward bought Alaska for the United States no man was, perhaps, on the day of the consummation of the sale, regarded as a greater fool than he. But time and research have revealed the wealth of resources that lie buried beneath the chilly surface of our most northern possession. And Seward's judgment is vindicated.

One of Alaska's greatest assets is coal. At this time that sounds inspiring; it is like the answer to a shipwrecked sailor's signal. The Geological Survey estimates that Alaska treasures more coal than did Pennsylvania before that commonwealth's coffers were tapped.

Is not the Seattle Chamber of Commerce then to be congratulated for at this critical time calling attention to the possibilities Alaskan coal offers for supplying the West and Northwest? Think what it would mean to the eastern half of the United States if now the present mines had to supply only the East. Every ton of coal that can be spared is sent to the Pacific Coast via the Panama Canal, and enormous quantities are sent from the East over the rails to the remote West. It is reported that 25,000 cars of coal started for the Lakes, to be shipped by water into the Northwest, arrived after navigation closed and that these bearers of the treasure still lie sidetracked somewhere. Maybe the report is true; but it seems incredible that it should not have been carried on to its ultimate destination by rail or dumped into the Middle West, where coal shortage has driven mayors and at least one governor to extreme measures to get relief.

The oils of the Pacific Coast by no means offer great and continuous supply of that fuel. The country west of the Rockies is growing, and with the growth the demand for coal increases proportionately. The railroad congestion and coal crisis have taught the value of using that fuel nearest the place of consumption. The Government could do no greater service to the nation than to be most reasonable in promoting the development of coal mining in Alaska. Doing so would doubtless lend impetus to industrial growth not only in Alaska, but all down the Pacific Coast and as far inland as that coal can be economically transported.

Why New York Has No Coal

AS THIS issue goes to press there is talk of pooling the anthracite coal for New York City and southern New England. Much of this coal comes in over the rails to Perth Amboy, N. J., from which it goes by barge to the sections of the country where it is consumed.

What pooling the anthracite arriving at this port will do to relieve the critical conditions, provided labor and other vital factors are properly cared for, may be judged by reading the account of conditions at this port as given on pages 178 and 179. There is no need of going into particulars here, as they are given in the article; suffice it to say that conditions there are deplorable.

J. D. A. Morrow, Secretary of the National Coal Association, has been appointed by Dr. Garfield to assume general charge of distribution. This is a most commendable move. Certainly, no part of the whole coal problem is in need of greater and competent attention than that of distribution. Mr. Morrow's experience fits him for his new job. Certainly, it is the hope of all Atlantic Coast sections of the country that Mr. Morrow will not only get the authority he will need to accomplish results, but will use it fearlessly when he gets it. Hampton Roads, New England and the New Jersey ports have plenty for him to do.

The Reason There Is No Coal

That the coal-unloading piers are the key to the critical coal situation in New York City is clearly evident from the following, which is from a recent report of the Coal Conservation Committee of New York State.

THE following are the docks with the railroad serving each: Undercliff, Erie R.R.; Weehawken, N. Y., O. & W. R.R.; Hoboken, D., L. & W. R.R.; Port Liberty, C. R.R. of N. J.; Port Johnson, C. R.R. of N. J.; Port Reading, P. & R. Ry.; Elizabethport, C. R.R. of N. J.; Perth Amboy, L. V. R.R.; S. Amboy, Penn. R.R.; St. George, B. & O. R.R.

Capacities are based on what it is estimated the docks can do under normal weather conditions. The total tonnages of the docks on this basis are 2615 cars per day. Averaging a car at 40 tons, this would amount to from 100,000 to 110,000 tons per day.

The following figures were given as representing a fair average cars per day for the dumpings under normal winter conditions: Undercliff 150 to 160, Weehawken 115 to 120, Hoboken 225 to 250, Port Liberty 60 to 70, Port Johnson 60 to 75, Elizabethport 75 to 100, Port Reading 225 to 275, Perth Amboy 150 to 200, South Amboy 300 to 325, St. George 75 to 100. A total of 1675 cars on the outside figures, or in tonnage a matter of 65,000 to 70,000 tons.

Thawing Facilities—Undercliff: Covered steam house with capacity for 48 cars at one setting; also have spear system with accommodation for 8 cars at one setting, or total of 56 cars. The house is old, having been used for a number of years; the average time required to thaw coal in this house being approximately six hours. Spear system requires about the same length of time by reason of the fact that an insufficient number of spears are applied to each car.

Weehawken: Spear system in use; accommodation for 40 cars at one setting; average length of time for steaming, 4 hours.

Hoboken: Spear system; accommodation for 40 cars at one setting; average time, 4 hours.

Port Liberty: No facilities for steaming.

Port Johnson: No facilities up to this date. One locomotive is being put into operation to furnish steam.

Elizabethport: No steam plant, coal being thawed by use of locomotive. One locomotive can take care of two cars at one setting. The number of locomotives furnished for this purpose is two, thawing out four cars at one setting; one pipe being applied to each car, and average time for steaming forty-five minutes to a car.

Port Reading: House steam equipment for 44 cars at one setting. Time required, two hours on bituminous steam coal, and on anthracite fine sizes several hours.

Perth Amboy: Spear system equipment for 24 cars at one setting, average time of steaming, 3 hours.

South Amboy: House steam, capacity for 40 cars at one setting; average time, 2 to 4 hours.

St. George: No steaming facilities. At St. George a steam plant accommodating 40 cars will be ready for use in a few days.

Perth Amboy: The Lehigh Valley expect to have a new plant ready some time in February which will increase their capacity to 96 cars. This plant was ordered long ago and was originally promised for delivery on Aug. 1, last.

With reference to labor, the following docks are short: Undercliff, Weehawken, Hoboken and Port Reading.

Aside from the question of shortage of labor, most of the piers are handicapped by "green labor."

South Amboy now operating 24 hours, is not operating to capacity by reason of insufficient coal supply. This port could load more tonnage.

Undercliff, which is working on a 10-hour basis, could materially increase its tonnage if put on a 24-hour basis.

In addition to this if steaming facilities could be promptly devised, such as furnishing locomotives, Port Liberty, Port Johnson and Elizabethport could load more tonnage by working 24 hours.

At the pier at Undercliff, Weehawken, on the morning of the 27th, there were available for individual shippers 142 cars of which only 45 cars could be released that day on account of no individual shipper apparently having sufficient coal of proper sizes to make a cargo beyond 45 cars.

It seems that at this time there is ample equipment to take care of the movement of coal from piers to harbor points.

The Conservation Committee recommends to Mr. Wiggin, Fuel Administrator for New York State:

1. That a practical railroad official directly connected with or in charge of each dock, meet at 2:30 Friday at this office and be empowered to coöperate with this committee, to go more fully into this matter, and make any practical recommendations that they think will be necessary to meet this critical situation.

2. It is recommended that all docks immediately arrange to work twenty-four hours daily.

3. That all docks increase their steaming facilities for the thawing of this frozen coal to the maximum immediately.

4. That this committee recommend the pooling of all coal so that no additional time may be lost in switching.

5. That this committee recommend that any culm, silt or any anthracite steam sizes containing material that will pass through a one-sixteenth inch mesh, otherwise dirt, be temporarily eliminated until such time as all the larger sizes of coal be dumped, as it is found upon investigation that the time consumed in unloading a car of this coal materially interfered with unloading other sizes.

6. It is recommended after our investigation that every effort be made to increase labor and the locomotive service at these docks, which is found to be inadequate.

7. That the docks work Sundays and holidays till the present stringency is past.

These recommendations have been in the hands of the national, state and city fuel administrators long enough for action. The conditions are more severe than this report reveals, as will be told on the editorial pages of next week's issue.

Correspondence

Coal Shortage and the Southern Power-Plant Operator

With the demand for coal exceeding the production by thousands of tons, there must of course be less consumed to prevent crippling industries dependent on coal for power. Everything possible should be done to lessen the serious fuel famine in the East, where hundreds of highly necessary industrial enterprises are located, and partially solve the fuel problem. After giving the matter careful thought and after visiting hundreds of power plants in the South, I have come to the conclusion that one solution of the difficulty would be to use wood for fuel. The South has an abundance of various kinds of wood that could be used.

About 50 per cent. of the South's population is rural or in towns up to ten thousand population. In these towns there are power plants which develop from a hundred to a thousand horsepower and consume thousands of tons of coal. Ninety per cent. of the boilers in these plants are of the horizontal type and can easily be converted from coal to wood burners, and at the present prices of coal the change would be economical in many cases, even though the various heat losses should increase. It may seem that the labor cost in stoking would increase, but a close study of local conditions shows that there will be a reduction instead.

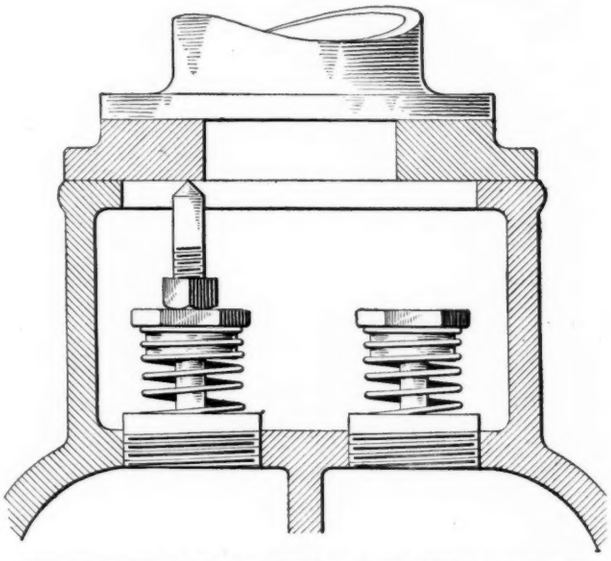
January and February are months of little activity with team owners and common labor, so that wood could be cut and hauled in these months at a very low price. Four-foot wood seems to be preferable as it dries quickly and can be handled easily. When trees of from six to twelve inches in diameter are cut, the wood should be quartered and stacked on end. If cut into smaller pieces, the fire burns too fast and the furnace doors have to be opened too often, in firing, to allow a steady combustion; but the larger size can be handled easily, and the fire can be kept burning constantly with a minimum of door manipulation. If the removal of the bridge-wall becomes necessary, it will neither affect the draft nor increase the fuel consumption to any extent. It has been my experience that it is possible to fire both on the grate bars and partly in the combustion chamber with good results. With coal, of course, this would be absurd, but wood will burn well in such a position and not simply char as might be expected. If green wood is being used, one must keep the furnace full so as to produce a drying condition. At each firing the dry wood should be raked from the combustion chamber to the fore part of the grates; in this way the fire will be constantly replenished with dry and partly ignited wood. In stoking one must be careful not to injure the blowoff pipe. To avoid this an iron bar might be placed in front of it to check a blow that might occur.

With a careful study, expenses can be minimized and the consumption of wood can be reduced by timing the stoking and feeding the water into the boiler as the intensity of the heat varies. By heavy firing the labor is reduced and one man can stoke just as many boilers as when burning coal. Experience will enable the fireman to work his fire, draft and water in such a way as to keep steam constantly at the desired pressure.

Newport News, Va. G. N. McILHENNY.

An Emergency Pump Repair

When a 12 x 7 x 12-in. duplex pump in our plant failed to supply its full amount of water and began to "cut up capers," it was shut down and the handhole plates were removed from the valve chamber on the water end. One valve seat, valve and spring were found out of place, for the threads had stripped on the valve seat, allowing it to be forced out of place. The pump was urgently needed, so it was repaired temporarily by



IMPROVISED JACK TO HOLD VALVE SEAT IN PLACE

cutting a piece of ⅝-in. round iron the right length to reach from the top of the valve stem to the top of the inside of the valve chamber. One end was threaded and a ⅝-in. nut screwed on the thickness of the nut; the upper end was pointed as shown in the illustration. The valve seat was wrapped and "doped" with red lead. The bolt was put in place and then backed part way out of the nut, forcing the seat down tight into its place and holding it there. The pump was out of service only a few minutes. E. M. KEYS.

Montesano, Wash.

How To Distinguish Iron from Steel Pipe

Those who specify wrought-iron pipe should be able to determine whether the pipe delivered to them is actually iron or not, and in the case of old pipe it is also interesting to know whether it is iron or steel. Four different test methods may be used for distinguishing

iron from steel, and these are, in the order of the ease with which they may be made, as follows:

1. Crushing Test: Cut a ring an inch or two wide from a length of pipe and hammer it flat, so as to obtain a fracture. The structure of iron is fibrous, while steel is crystalline. Steel is difficult to fracture, and the fracture is bright crystalline; iron is more easily fractured, and the fracture is distinctly fibrous and of a dull gray tone.

2. Rough Etching Test: Submerge one end of a test piece in a solution of equal parts sulphuric acid and water. After five or ten minutes the end of pipe, if iron, will begin to show a number of fine concentric rings just as though it had been made from a number of sheets of paper pasted together. This appearance is caused by the acid eating away the iron more quickly than the noncorrodible layers of slag popularly referred to as "cinder-rings." Steel has no slag incorporation, therefore will show smooth, without layers. The acid or any other accelerated test is no indication of the rust resistance of metals in service, for the acid dissolves the metal, while corrosion in service is a gradual combination of iron and oxygen, forming rust.

3. Microscopic Examination: The surface of the metal when highly polished will exhibit the structure—the crystalline structure of steel, and in wrought iron, the even grains and slag inclusions in the form of irregular but extremely fine strands or fibers of slag separating the grains of iron.

4. Chemical Analysis: The chief differences are the relatively high silicon and low manganese content of iron, and the analyses will show about as follows:

	Iron Pipe, Per Cent.	Steel Pipe, Per Cent.
Silicon	0.15	0.05
Manganese	0.05	0.30
Sulphur	0.02	0.05
Phosphorus	0.15	0.10
Carbon	0.04	0.13

The high silicon in iron is due to the slag content, which is actually as high as 6 per cent. (by volume) in iron; but this is not shown in ordinary chemical analysis, as the slag is not chemically combined with the iron. The higher manganese in bessemer steel is the result of over-oxidation of the metal and the addition of manganese to the molten mass to make it suitable for rolling and welding.

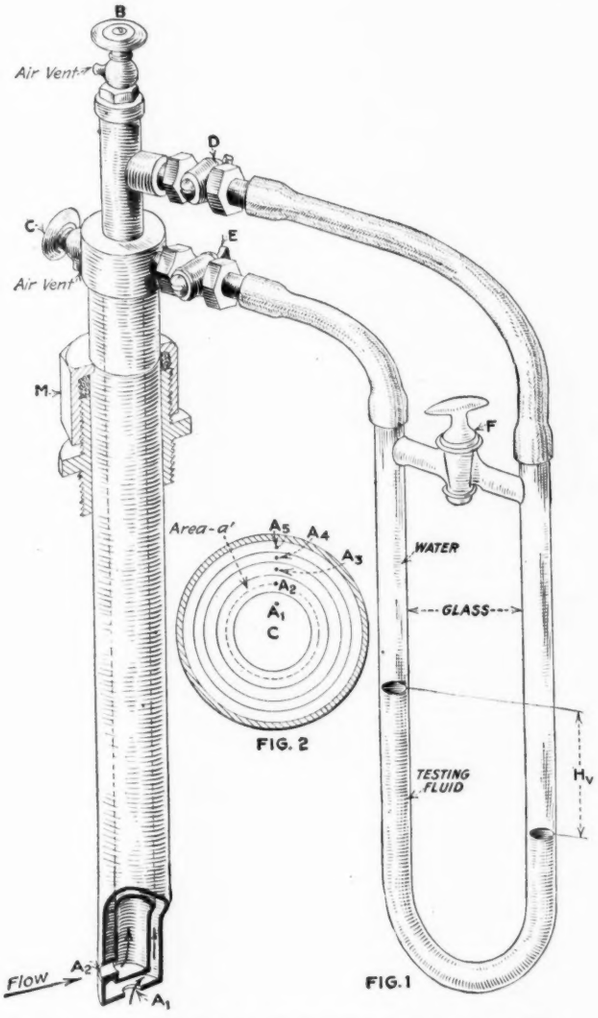
N. BOWLAND.

Pittsburgh, Penn.

Using a Pitot Tube

The article in the issue of Oct. 23, page 557, by W. V. White, on the pitot tube, impresses me as misleading, as it contains many statements that are incorrect. I have used a standard pitometer for measuring and checking the individual discharge from some twenty-five pumps, rated at 13 to 52 cu.ft. per sec., and probably a brief description of our method will be of value to readers of *Power*.

Our pitometer is shown diagrammatically in Fig. 1. There are two tubes, one within the other, and connected by rubber tubes at the top at D and E. At the bottom a small opening in each tube allows the outside pressure to be transmitted independently to each tube. These openings stand at 90 deg. to each other, as shown at A_1 and A_2, and when the flow in the pipe is in the direction indicated by the arrow, the pressure in the outer tube is the static pressure or head, and that in the inner tube the static head plus the velocity head, as this aperture receives the pressure due to the impact of the flowing water. These pressures, when transmitted through the hose to the U-tube or differential gage, produce a difference in level of the balancing fluid, proportional to the velocity head. This balancing fluid must, of course, be heavier than water, else there would be a continuous flow from the high- to the low-pressure side. For high velocities we use mercury, and for low velocity carbon tetrachloride, which is about 1.6 times as heavy as water and will not mix with it. By coloring the



PITOMETER FOR DETERMINING FLOW IN PIPES

tetrachloride with a little cochineal, a sharp line of demarcation is produced. This deflection of the balancing fluid shown as H_v does not represent the velocity head. It is partly balanced by a column of water of equal height in the opposite leg of the U-tube. Assuming the specific gravity of the fluid to be S, as compared with water, then the difference in pressure between the two sides would be equal to $(H_v \times S) - (H_v \times 1)$ or $H_v\ (S - 1)$. Theoretically, the velocity would be $V = \sqrt{2gH_v\ (S - 1)}$. But here the formula must be modified. It is found that the actual deflection H_v is more than the actual velocity warrants, owing to the various shapes of the orifices, their positions, etc. Hence

the value $\sqrt{2gH(S-1)}$ is modified by a constant C called the coefficient of the pitometer. Then the actual velocity would be $V = C\sqrt{2gH_v(S-1)}$. This coefficient is obtained for each instrument by towing the tube through a body of still water at a known velocity and noting the deflection H.

It is worse than useless to assume that any point in a pipe represents conditions of average flow. The point varies with every pipe and may not be in the same place twice in the same pipe, if the delivery is increased or diminished, as shown in hundreds of tests. The only reliable way is dividing the cross-section of the pipe into a number of equal concentric areas, as shown in Fig. 2, and placing the tube orifices at a predetermined point in each ring, both above and below the pipe center. These points must lie on concentric rings which divide the respective rings into two equal areas. The average of these individual velocities gives the average velocity of flow. Note that to obtain the average velocity by using the average deflection would be wrong, as the velocity is proportional to the square root of the deflection. The coefficient of our pitometer is 0.72. We have a 1-in. corporation cock tapped into the top of each discharge pipe. The pipes vary from 15 to 36 in. The end of the pitot tube is pulled up into the recessed nut M, which is screwed on the top of the corporation cock which is then opened and the tube pushed down into the pipe. A stuffing-box at the top of the nut M prevents leakage. By means of a pointer attached to the top of the tube, and a scale, the orifices can be placed at any desired point in the pipe, in a vertical line from the cock. As obtaining the readings of the cross-section of, say, a 30-in. pipe is a matter of half an hour, care must be taken to read the center of the pipe from time to time, to make sure that the flow remains uniform.

The foregoing may create the impression that the use of a pitot tube is a complex matter, while as a matter of fact it is simple after the necessary tables are figured out, and these do not involve more than simple algebra. The chief objection to a home-made tube is its unknown coefficient, which must be determined with some degree of accuracy to make the instrument of any value for test purposes. When checked against a weir, our tube showed a difference of 2 or 3 per cent. W. F. BRYE.

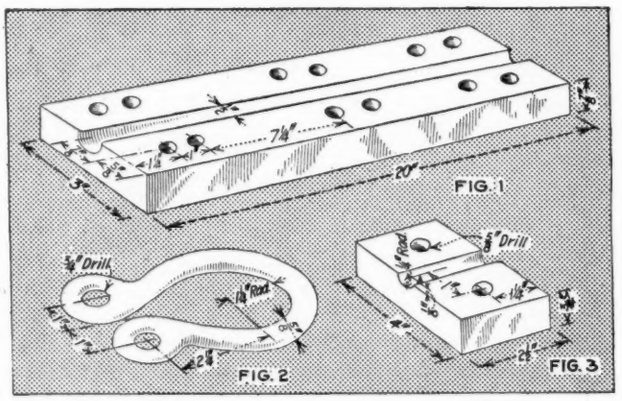
Patterson, Calif.

Home-Made Wire Straightener

The article, "Home-Made Wire Straighteners," in the Nov. 27, 1917, issue of *Power*, brings to mind how the straightening of about 6000 ft. of No. 0000 bare-copper wire was accomplished at one of our mines. When we received this wire, it was in bundles containing lengths of from 300 to 500 ft. The rolls were of small circumference, and in several places the wire had sharp bends in it.

At first we tried to straighten the wire by laying it on a wooden block and hammering it with wooden mallets. But this was too slow a process and I set about devising a quicker way of doing the job, the result of which was the straightener shown in the figures. This device is made of two pieces of metal of the dimensions shown in Fig. 1, riveted together and mounted on a wooden block set in the ground as in Fig. 4. The straightening was then done as follows:

One end of a cable was made straight for about two feet and pushed through the straightener; then the clamp detailed in Figs. 2 and 3 was placed on the end of the wire extending through the straightener, as in Fig. 4, and a horse used to pull the bent wire through the straightener. The straightening was then done as fast as the horse could walk. The slots in the two halves of the straightener were made on a planer, as we did not have any drill long enough to drill the hole after the two parts had been assembled. Wire of any size can be straightened by making the hole in the



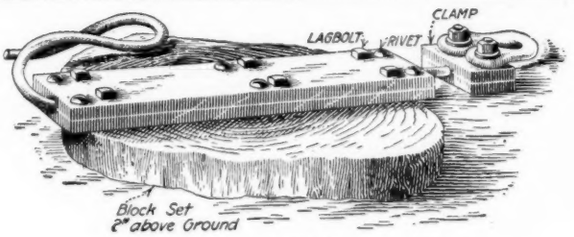


FIG. 4

FIGS. 1 TO 4. PARTS AND ASSEMBLY OF WIRE STRAIGHTENER

device to fit the wire. The corners at the end of the hole should be well rounded to prevent damaging the wire. I have never tried to use this straightener on insulated or lead-covered insulated wire, but I see no reason why it cannot be done. THOMAS J. PASCOE.

Norway, Mich.

Change of Water for Air Pump

Replying to L. F. Forseille's question, "Would change in water for air pump be good or bad," in the Nov. 20, 1917, issue of *Power*, page 703:

The change as indicated by the sketch would not be advisable and if tried would probably result in a loss of 0.5 to 1.5 in. vacuum under full-load conditions. This loss in vacuum would be caused by the warm-water injection for the air pump having a higher temperature than that corresponding to the temperature of the vacuum in the condenser. Some of the water would be evaporated, filling the space that should be filled with air from the condenser; also, the warm water coming in contact with the cooler air from the condenser would cause the air to rise in temperature and increase in volume. This would reduce the efficiency and capacity of the air pump. The air pump and condenser were operating with injection water of the same temperature, when no bad effect was noted with a 75-

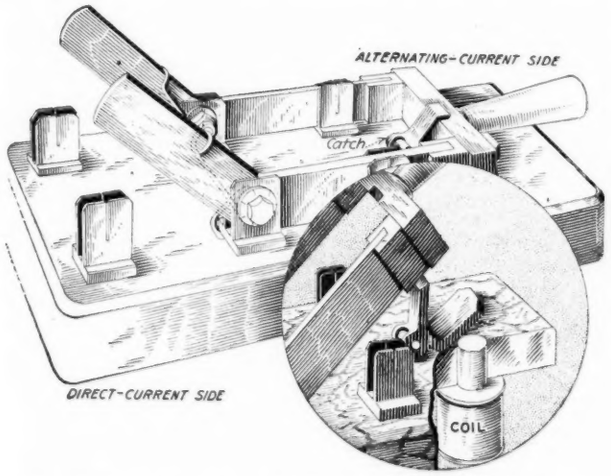
deg. F. rise in the temperature of the injection water. The trouble due to ice obstructing the flow of water through the strainer could be overcome by constructing an air-pump discharge pit. The air-pump injection-water supply would be from the discharge pit. Some arrangement must be made to supply cold makeup water, so as to keep the air-pump injection water within 2 deg. F. of the condenser injection-water temperature. Should this arrangement fail to reduce the work on the pump turbine or fail to get an ample water supply to the condenser, I would suggest that a larger set of nozzle blocks be put in the turbine to increase its capacity and do the required amount of work.

Montgomery. Ala. J. E. CRAVEN.

An Emergency Lighting Switch

Some power plants, in case of a shutdown at night, use lanterns lighted and placed in convenient positions where they can be readily secured in case of an emergency. However, there are many plants that go without any protection against being left in darkness, and others use small gas lights. The method I saw used some time ago in a substation looked to be as about as satisfactory as any for emergency lighting.

The lighting switch for the building was double-throw and of a type shown in the figure. The right-hand contacts were connected to 110-volt alternating current, and the left-hand terminals connected to 112-volt direct current coming from an auxiliary battery used for remote control of the oil switches. The lighting circuit connected to the two middle contacts. Between the studs on the alternating-current side on the back of the switchboard, a magnet coil was arranged as shown in the sectional view and connected across these studs.



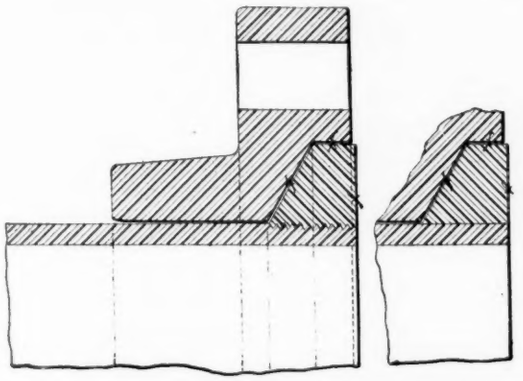
DOUBLE-POLE, DOUBLE-THROW LIGHTING SWITCH

This coil held the switch closed to the alternating-current supply under normal conditions. Springs were placed on the middle studs to throw the switch to the opposite position when released by the magnet coil. In this way, if the alternating-current source failed, the switch was thrown to the battery circuit, thus lighting the station from this source. After the plant was running all right again, the attendant would throw the lighting switch back on the alternating-current side.

New York City. D. R. HIBBS.

Combination Pipe Joint

The need of a pipe joint suitable for any pressure, which can be attached to the pipe, on the job, without expensive equipment, has long been recognized. The combination joint, two types of which are shown in the illustration, was designed by me for use on all lines requiring flanged joints. It consists in attaching a metal collar or band to the pipe by means of ordinary pipe thread, shrinking, welding or a combination of these methods; the collar or band to form the joint or gasket face, followed and held in place by a flange loose on the pipe, similar to the Van Stone type.



MEANS OF ATTACHING FLANGES TO PIPE

This joint can be attached to pipe of any material and gives a wide scope in method of construction, combining a screwed and welded, a screwed and Van Stone, or a shrunk, welded and Van Stone joint, which does not depend entirely on the weld. The joint is somewhat flexible, and the holes can be aligned by turning the loose flange; and in case of cutting a length of pipe the flanges can be used again, which is impossible with a welded flange.

The screwed and peened joint can be made in any pipe shop with ordinary tools and gives the flexibility of the Van Stone type joint. In fact, it has all the good points of the Van Stone joint and does away with the distorting, thinning or the welding on of a reinforcing facing piece to bring the pipe up to original thickness. The collars, or bands, can be machined to form male-and-female or tongue-and-groove joints. In general this joint can be used on all lines in the plant, on pipe of any material and attached to suit conditions.

Midland Beach, S. I., N. Y. HOWARD C. THAYER.

Artistic License

Four *barefoot* men in a row, three shoveling coal into furnaces! What do you think of it? *It cannot be done.* Mr. Weil must have peculiar ideas of a boiler room of a warship, in which men go around in their bare feet. How about cleaning fires? When they pull "the backs out" and "shove the fronts back," do they put on their shoes then? Strange that a picture like this ever got past the censor for an engineering publication like *Power*. J. H. HOCKING.

New York City.

[Regarding the illustration portion of the foreword of Jan. 15.—Editor.]

The Lubrication of Steam Turbines

From papers on steam-turbine lubrication submitted by the following members of the Lubrication Engineers' Association of the Texas Company: W. M. Davis, John H. Young, Jr., H. D. Gohlman, J. M. Prewitt, H. J. Wilson, J. B. Barton, W. O. Kroenke, W. A. Edmondson, H. W. Salbador, J. T. Snow, D. L. Keys, F. J. Davis, J. A. Hansgen, W. G. Craig, G. M. Shanks, S. J. Hunt, W. H. Grose and Walter L. Foster. The article is from "Lubrication," published by the Texas Co.

THE weight of the turbine is small, compared with that of a piston engine of the same horsepower. For this reason and owing to the freedom from reciprocating motion, the foundations required for turbines are of small size and light weight, there being little vibration to be absorbed under proper conditions of aligning and balancing.

Turbine-oil consumption is more than the oil consumption for any other prime mover, the loss of oil being due chiefly to leakage and a small amount of evaporation. Since there is no internal lubrication, the steam is not contaminated with the oil and therefore the condensed steam is immediately available for boiler-feeding purposes without purification; and this re-use of condensed steam effects a large saving in the cost of feed water and in the expense of the maintenance and cleaning of boilers. Again, superheat, as used in the turbine, imposes no restrictions in the choice of lubricants. Finally, the turbine can usually be started and loaded more quickly than the piston engine.

Heat From Turbine Affects Bearings

The rotating parts of the turbine proper are connected to and revolve with the shaft, so that the bearings that support the mainshaft are the only parts that require lubrication. These bearings are on either side of the turbine and are subjected to radiated heat from the steam passing through the turbine. Turbine lubrication is accomplished either by ring oilers or by some form of circulating system. Ring-oiling bearings are used on small types of turbines, the rings dipping into a reservoir of oil and carrying the oil to the bearings to be lubricated. This method has been found satisfactory where the bearings are adjusted so that the rings do not vibrate and are free from sharp edges that may interfere with their free play and, what is of still greater importance, where the reservoir into which the rings dip is of sufficient capacity to permit the oil to rest. Lubrication difficulties are sometimes experienced on certain types of turbines equipped with ring-oiling bearings because of the radiated heat. This affects particularly the governor bearing, which sometimes reaches a temperature of 240 deg. F. Fig. 1 shows an oil-ring bearing.

Larger types of turbines are usually lubricated with a self-contained circulating system which cools and strains the oil before forcing it back to the bearings under pressure. The oil is used over and over again, the relative size of the oil system determining how frequently the same oil is fed to the bearings. With this oiling system the highest temperature is experienced on the governor bearing, the next highest on the inside turbine bearing, the inside and the outboard generator bearing both being lower in temperature. The oil is in constant agitation, frequently with water that leaks past the packing glands, and unless the oil is a high-grade one, it will emulsify. Sufficient oil must be added from time to time to the system to maintain the oil level, making up for what is lost. A section of a typical, modern steam turbine, showing the self-contained oil-circulating system, is shown in Fig. 2. Oil from the various bearings flows by gravity into reservoir *B*, and a small rotary pump *A*, usually driven from the governor shaft, takes this oil and forces it through the cooler *C* and thence through pipes *D* to the various bearings. A spring relief valve *L* bypasses any excess oil back to the storage reservoir. In some systems, instead of using a relief valve *L*, the oil is discharged into an overhead reservoir and allowed to flow by gravity to the bearings. The turbine shown in Fig. 2 has four main bearings, *E*, *F*, *G* and *H*. These are hollow and cooled by circulating water. The oil is fed into the top of the bearing at the center and flows out at each end. It then drops down to chambers in the turbine casing and is collected by the return pipe *J* and returned to the reservoir *B*. A screen *K* is provided in the reservoir to remove large particles of solid matter. There are several places where the water finds its way into the oil, the main one being the packing gland *M* at the high-pressure end of the casing. Turbine manufacturers employ various methods for preventing steam leakage at this point, such as carbon packing held against the shaft by springs, labyrinth packing and water seals, but in spite of these precautions some steam always leaks out and travels along the shaft and, coming in contact with the water-cooled bearing at *E*, condenses and mixes with the oil. When turbines are operated on

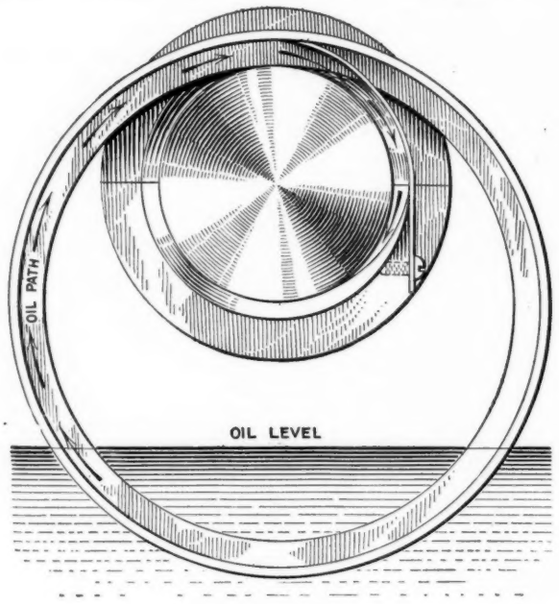


FIG. 1. OILING RING

back pressure, there is also an outward leakage of steam at the gland end on the other end of the turbine. Occasionally, the cooler *C* or the hollow water-cooled bearings will develop small leaks, permitting water to get into the oil. A drain pump *P* is provided in the bottom of the reservoir *B* for drawing off the water that collects at this point, and should be drained off regularly. As the oil passes rapidly through this small tank, there is not sufficient time for complete separation of the water, especially when it is considered that the water and oil are thoroughly churned in passing through the rapidly moving bearings. Furthermore, steam-turbine bearings are usually run very hot and the cooking process through which the oil passes in coming in contact with the leaking steam and hot water makes an intimate mixture of oil and water. Taking these points into consideration, it is evident that it is necessary to provide something more than the coarse screen *K* to thoroughly purify the oil.

Where a separate filtering system is used, considerably more oil is in circulation, it has more chance to rest and the water and impurities in it are removed, thus prolonging the life of the oil. One of the important advantages of a filtering system when used with the oil-circulating system is that it makes it possible to keep the cooler tubes clean. Unless a filtering system is used, the dirt that forms in the oil, due to water and foreign matter and, with some

oils, to oxidation on account of high temperatures, the solids in the oil will collect in the coolest part of the turbine oil-circulating system, which is the cooler. As this dirt collects, the walls of the tubes or pipes of the cooler get a thicker coating on them and their conductivity decreases so that the full benefit of the cooling water is not realized. As this process goes on, the cooling effect in time is lost and oil will be circulated at a very high temperature. Moreover, dirt in the oil will eventually find its way to the bearings and in time, if the water that collects is not taken out, a mixture of water and oil will be fed instead of oil. Steam-turbine oiling and filtering systems may be classified as follows:

1. Continuous circulating systems in which oil used on the bearings is continuously passed through the system which filters all or part of the oil. In Fig. 3 is shown a gravity cooling and filtering system especially designed and adapted for the lubrication of steam turbines. Oil from the bearings is drained into the oil reservoir in the turbine, from which it is delivered to the filter by a pump geared to the turbine. The first filtering process precipitates the water, the oil overflowing into the filtering compartment. The speed of oil circulation is such that it would be impracticable to filter all the oil, but the heaviest and dirtiest portions are, by virtue of their greater weight, compelled to pass through the filter. The clean part escapes the filtering operation, but all the oil is compelled to pass through the cooling compartment before it reaches the vertical oil-storage tank, from which the lubricant is fed directly to the bearings. This vertical tank is placed immediately adjacent to the cooling compartment of the filter.

2. Batch filtration, in which all the oil contained in a turbine-oiling system is removed and purified, the turbine being supplied with a fresh batch of clean oil to permit it to operate while the dirty oil is being cleaned. With this system the oil in one turbine after another can be filtered and the oil from the clean-oil compartment of the filter may be pumped into the turbine from which the dirty oil has been removed. This is the system ordinarily used where filtering systems have been introduced. In partial filtration, which was described in an article in an earlier issue of *Lubrication*,[1] part of the dirtiest oil is continuously removed from the circulating system, passed through a filter and returned to the system by a steam pump automatically controlled by the head of oil in the clean-oil compartment. In forced-feed systems which have been used in the lubrication of the Curtis vertical turbines, where the weight of the revolving parts has to be supported by hydraulic pressure, a tank large enough to contain all the oil and fitted with straining devices and cooling coils, where connected with a separate filter, is situated at a suitable level for receiving oil by gravity from all points lubricated. The oil is drawn from this tank by a pump which delivers it at a pressure about 25 per cent. in excess of that required to sustain the weight of the turbine in the step bearing. A spiral duct is situated between the source of pressure and the step bearing, and this regulates the oil supply and renders the flow more uniform. This source of pressure is also connected through a reducing valve to the upper oiling system of the machine, where a pressure of about 60 lb. is maintained. This system, which includes a storage tank partly filled with compressed air, operates the hydraulic governor mechanism and supplies oil to the upper bearings. The regulation of oil to these bearings is effected by means of adjustable baffles. Pipes from the upper bearings and from the hydraulic cylinder and release valves all discharge into a common chamber, in which the streams are visible, so that the oil distribution may always be under observation.

Previous to the adoption of turbines, it was generally believed that only fatty oils would emulsify with water, and that a mineral oil would separate from water. But it was soon discovered that the speed of the turbines was so great and the churning action so violent, that a petroleum oil that was not properly manufactured would form a permanent emulsion with any water with which it came in contact.

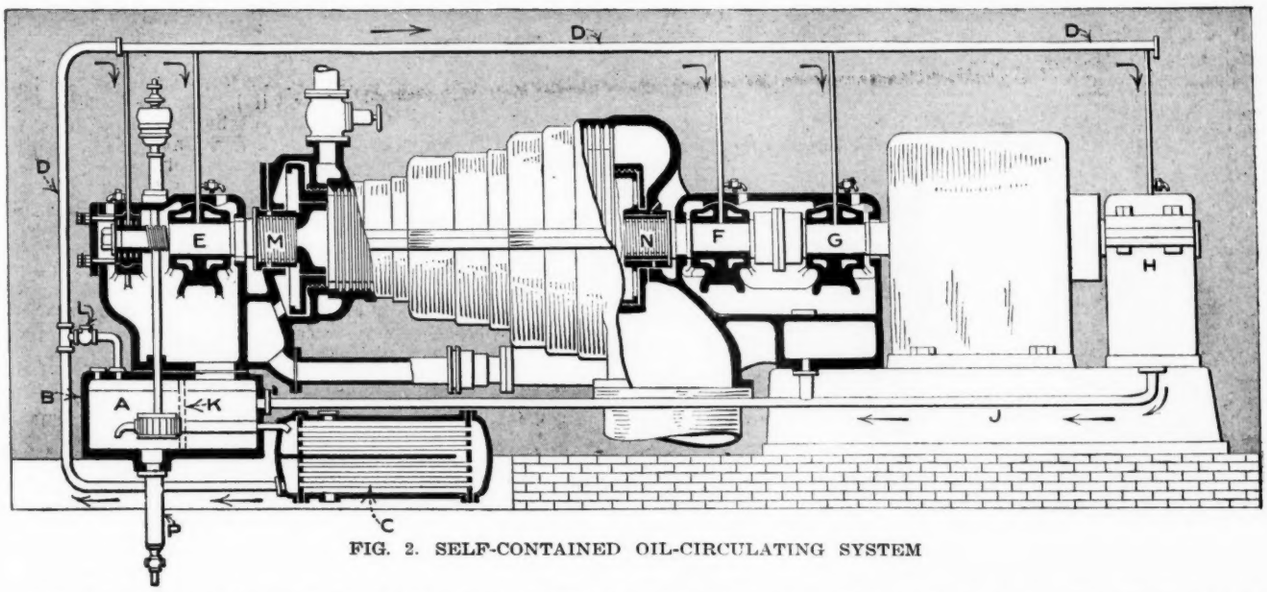


FIG. 2. SELF-CONTAINED OIL-CIRCULATING SYSTEM

As an illustration of a severe case of emulsification with a paraffin oil, the case of a lead mining and milling plant in Missouri, a few years ago, may be cited. This occurred in the lubricating system of two vertical Curtis turbines fitted with a larger filter of several barrels' capacity.

The chief engineer complained that he had found it necessary to add several barrels of new oil to the system every month, and since no leaks could be found, he was at a loss as to the cause of the rapid consumption. Upon careful examination it was found that the water in the filter and settling tank was milk white, and the engineer explained that he had to draw off the water several times a day to avoid an overflow. By way of explanation he opened the drain pipe and allowed some of the water to run off. A large glass jar was filled with some of this waste water, and after it had settled there was a layer of oil found on top of the water and the water still remained a milk-white color, indicating the presence of oil still held in suspension.

With paraffin oils the peculiar conditions encountered in the bearings and the system generally may cause a partial separation of the oil and paraffin, and the subsequent contact of the oil with the cooling coils of the system results in a deposit of the paraffin, thus interfering with the proper functioning of the coils.

[1]Turbine Oil Filtering Systems, by Edwin M. May, "Lubrication," Vol. 3, No. 11, September, 1916.

In a previous issue of *Lubrication*[2] the conditions which have to be met by a turbine oil were stated as follows:

The demands made upon an oil in a turbine are exceedingly severe. The oil must circulate at high speed through innumerable valves, pipes and bearings, subjected first to high and then to low temperatures, and to many variations in pressure. It is thoroughly mixed with air, so much so that foam is quite frequently found on top of the oil in the settling or sump tank. Air bubbles can always be seen as the oil flows from the bearings. Frequently it must operate with a percentage of water which leaks through the stuffing-boxes or with water that leaks in from an imperfect or damaged cooler coil; or, in the case of marine installations, salt water can sometimes get into the system from overboard. At times the oil in the bearing in close proximity to the stuffing-box is actually cooked by the live steam. The steam carries with it boiler impurities or chemicals used for boiler-water treatment, and very often these chemicals in connection with the water and air cause the oil to form very bad emulsions. Any oil that has a tendency to form an emulsion is rather dangerous for use where the churning, heating and boiling with water and boiler compounds are carried on to such an extent as in a turbine lubricating system.

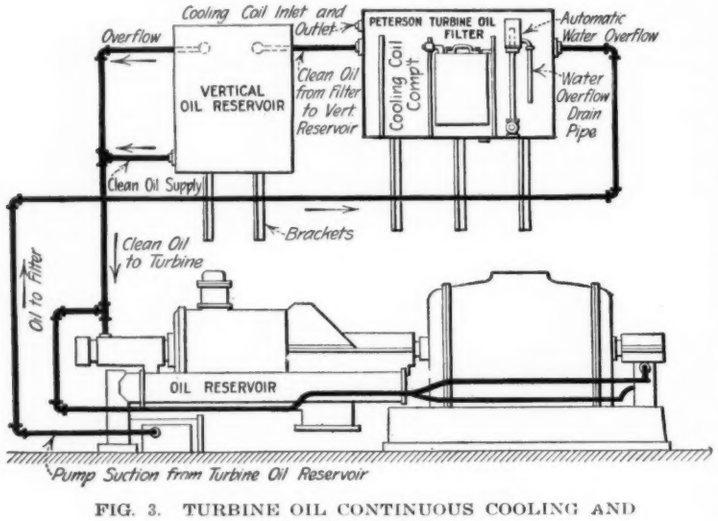


FIG. 3. TURBINE OIL CONTINUOUS COOLING AND FILTERING SYSTEM

Much damage has been done to turbines because of the tendency of certain oils to emulsify. Some oils will throw down a hard emulsion which, under conditions which prevail in the turbine, will cake in such a way as to actually stop up the pipes and oilways to the bearings. Other oils carry the water in suspension and are of such a nature that the water will drain off only with great difficulty. The best turbine oils, of course, are those that under all conditions will allow whatever water gets into them to drain off and will produce a minimum amount of emulsion, this emulsion being of such a nature that it will not form a hard deposit. The perfect oil is one of high lubricating body which will separate freely from any amount or any kind of water after it has been thoroughly agitated and even boiled and which will leave absolutely no permanent emulsion.

Next in importance is the question of viscosity. At one time the American oil manufacturers used the very lightest distillates for turbine work, the theory being that these lighter oils separated easily from water and formed less objectionable emulsions. The factor of safety, however, was exceedingly small with these light oils. The many mechanical difficulties experienced while these low-viscosity oils were in use resulted in the demand for heavier oils, until in some turbines doing very severe work, very heavy oils are now being used with complete success. The majority of turbines, however, can best be lubricated by a medium-bodied oil.

The following extract from the Terry Steam Turbine Co.'s "Instruction Book on Bearings and Lubrication" indicates the attitude of the turbine manufacturers on the subject of viscosity:

The viscosity of the oil used in any case must be suitable for the service. We are listing below oils recommended by several refiners for turbine work, in three ranges of viscosity roughly classified as light, medium and heavy. The approximate viscosity of each oil is given with its trade name. All viscosities are in seconds at 100 deg. F. by Saybolt Universal viscosimeter. These oils are tabulated for the convenience of the turbine user as being standard brands. If any oil named is found unsatisfactory for the purposes stated, please advise us for our information as soon as convenient.

a. Light oil, viscosity 130 to 200 sec., is best for turbines without reduction gears, either ring or forced feed oiling.

b. Medium oil, viscosity 200 to 350 sec., is used for turbines with reduction gears and either ring or forced oiling. It is better than a light oil for turbines subject to vibration either from within or from an external source. It will also allow slightly greater bearing clearances. Bearings may run a few degrees warmer with heavy oil than with the lighter grades.

c. Heavy oil, viscosity 350 to 500 sec., is useful in cases of bad vibration or of gears heavily loaded or causing noise. Many times gears can be successfully operated with heavy oil which would be noisy or show rapid wear with lighter oil. Heavy oil works well in turbine bearings except in places where exposure to cold sometimes makes the oil too sluggish. This applies especially to forced oiling units. When using heavy oil, more attention must be given to the oil when starting, to be sure that all rings run freely and that bearings are not flooded by the forced oiling systems.

The purpose of an oil is to form a film between the surfaces to be lubricated to minimize friction and to act as a cushion or dashpot to prevent vibration or pounding between the journal and the bearing or between adjacent gear teeth.

The lightest oil that will do this with certainty will give the lowest running temperature and usually the lowest cost per gallon. The best oil for a particular unit depends on operating conditions to a large extent, but in general the safe and economical oil to use is a grade slightly heavier than the lightest oil on which it will operate smoothly and quietly. [For an interesting article setting forth the formation, maintenance and function of the oil film in a journal bearing we suggest to the reader the following from *Power*: "The Lubrication of Bearings and Cylinders," Dec. 7, 1915. The Editors.]

Instructions To Erecting Engineers

In the August, 1916, issue of *Lubrication* the turbine-oil recommendations of the Westinghouse Machine Co. and Allis-Chalmers Manufacturing Co. were given. The following is quoted from the instructions of the Westinghouse Machine Co. to their erecting engineers:

So far as mere lubrication of the turbines is concerned, almost any oil at all has lubricating properties sufficient for the bearings to run cool, so that the fact of the bearings running cool and nice is no criterion of the suitability of the oil.

A large quantity of oil is in circulation in the turbines at a temperature of from 100 to 120 deg., or thereabouts, which temperature is conducive to any chemical reaction should the necessary elements be present. It is therefore important that the oil be an absolutely pure mineral oil, free from acid. Sometimes mineral oils are adulterated with animal fats, which will in the course of time decompose, forming acids, corroding the shaft, and even eating up the bearing metals.

The following is quoted from the recommendations of the Allis-Chalmers Manufacturing Co.:

We have found it generally true in steam-turbine lubrication that, while one oil may be suitable in the majority of cases, there are from time to time, turbines that seem to require either a heavier or a lighter oil and this makes it inadvisable to issue a fixed specification governing this one class of work.

A suitable oil for the lubrication of steam turbines must have certain general characteristics which, in the order of their importance, are as follows:

The oil must be so made and of such a nature that it will separate freely from water, and that water of any nature or any temperature being agitated with the oil in any amount will not form an emulsion; even if the conditions require the oil and water to work together so that a

[2] "Lubrication of Steam Turbines with Recommendations of Turbine Manufacturers," by W. F. Parish, in "Lubrication," Vol. 3, No. 10, August, 1916.

mechanical mixture of the oil and water is secured, the combination must not be permanent, but upon resting and being subjected to a heating temperature of not over 175 deg. F., the water must separate. Preference should always be given to the oil separating the most quickly after being agitated with water that will be used for boiler purposes at the plant where the turbine is located. Tests should be made by shaking 50 per cent. of oil and 50 per cent. of water in a bottle or by mechanically stirring this mixture in a suitable container for, say ten minutes, and noting the separation of water after ten minutes and after twenty-four hours.

Any oil that in the above tests, or in practice will throw down a deposit, should under no conditions be used for turbine lubrication, as this deposit may, under severe conditions, interfere with the flow of the oil to the bearings.

Oil in order to meet the above conditions, must be free from acids, free from all fixed oils such as vegetable and animal oil, and should be properly refined.

The leading manufacturers of lubricating oil have introduced the practice of determining a property known as "viscosity." To determine the body, or viscosity, of an oil a standardized viscosimeter is used, by means of which the time occupied in the flow of a measured quantity of oil through a small orifice at a given temperature is measured. The Saybolt Universal viscosimeter is commonly used for this purpose by the large producers and refiners of lubricating oil in this country, the sample of oil being maintained at a temperature of 100 deg. F. and the time occupied in the flow of the measured sample of oil through a small orifice being measured in seconds. This time reading represents the relative viscosity of the oil which, in the majority of cases for steam-turbine lubrication, should be about 200 sec. at 100 deg. F. Saybolt Universal.

Should it be desired to operate the turbine with a very slight reduction in temperature of the bearings, oil as light as 150 sec. viscosity for the majority of turbines can be used. On the other hand, should the mechanical conditions require oil of heavier body, an oil as heavy as 750 sec. at 100 deg. F. Saybolt machine, can be used. All these oils, however, irrespective of the body or viscosity, should conform absolutely to the separation from moisture or water tests. All other tests, such as gravity, flash, fire and color, have no bearing whatever for this class of lubrication, but it might be well to be more explicit in regard to these particular tests. . . . .

Temperature Proportional to Viscosity of Oil

The temperature of a bearing in a turbine working on a forced-feed system is in proportion to the viscosity or body of the oil; that is, if a very heavy-bodied oil is used, the partially resulting bearing temperature can be reduced to certain limits by the use of a lighter-bodied oil. There is a limit to the lightness of the oil, which, in the majority of cases, should not be less than 150 sec. viscosity on the Saybolt Universal machine. The temperature of a turbine bearing, however, is not a point of the greatest value in turbine lubrication. The oil heavy in viscosity has the very valuable feature of staying on the surface of the bearing after the turbine has come to rest, so that in starting, the surfaces are well lubricated. Further, heavy-bodied oils will take up bigger clearances and operate with rougher bearings and shafts without danger, whereas, under these abnormal conditions, light-bodied oils would invariably lead to trouble, as the oil would not have sufficient thickness of film to keep the high points of the surfaces apart.

The actual mechanical frictional difference, or the effect upon the mechanical efficiency of the turbine, between the use of a heavy and a light oil on a turbine having two or three bearings is infinitesimal.

Water is the main deteriorating element to the life of a turbine oil, therefore special attention should be given to keep water out of the circulating systems and out of all filters. The system should be a dry one, and daily inspection should be made to see that water is not getting in. The oil that will meet the water test can be used indefinitely in a turbine by being added to from time to time.

The following list of oils which have been used in our steam turbines and found satisfactory, is to be submitted by you, without recommendation, to any of our customers who request information regarding the kind of oil to be used in our steam turbines; the selection of the particular brand to be left to them . . . .

L. E. Strothman, Manager,
Steam Turbine Department.

Follow directions. Today the direction is to save two slices of bread, an ounce of meat, an ounce of sugar, a snitch of butter. Tomorrow as conditions change there will be new directions. FOLLOW DIRECTIONS.

Engineers for the New Merchant Marine

Plans now being matured by the Recruiting Service of the United States Shipping Board reveal a system of preparation in connection with manning the new merchant marine that for thoroughness will not suffer by comparison with any known example of German efficiency.

After securing chief engineers for service on the new-type, fast cargo ships now being constructed under its direction, the board will give the men an exceptional opportunity to learn all there is to know about the engines they are to operate by sending them to the Westinghouse works, where the engines, of the geared-turbine type, are being built. Each chief will follow his own engine through the process of construction and then to the shipbuilding yard, where he will supervise its erection on board the ship, and will take charge of it as chief engineer when the vessel goes into commission.

The Board probably will first call for 125 chief engineers for this work. While on this special duty a chief will receive both pay and an adequate allowance for board. On board ship he will receive the standard pay for his grade in the merchant marine, which is high, and a bonus for war-zone voyages.

The demand thus created for the services of chief engineers is expected greatly to stimulate activity among first assistant engineers who wish to become chiefs. To assist any men of this grade, or of lower grades, to secure promotion, the Shipping Board invites them to its free schools in Marine Engineering, where they may brush up on technical matters, from a week to a month, as they may choose. There are eight of these schools, located respectively at Massachusetts Institute of Technology, Cambridge, Stevens Institute, Hoboken, The Bourse, Philadelphia, Johns Hopkins University, Baltimore, Case School of Applied Science, Cleveland, Armour Institute, Chicago, University of Washington, Seattle, and Tulane University, New Orleans.

Shadowed!

—By Darling, in the N. Y. *Tribune*

JUST ABOUT ONE MORE FALSE MOVE AND—

Convention of the N. M. E. B. A.

The National Marine Engineers' Beneficial Association held its forty-third annual convention at Baltimore, Md., during the week beginning Jan. 21, with headquarters at the Belvedere Hotel. It was necessary for the convention committee to remove the meeting from Washington, D. C., this year, owing to the lack of hotel accommodations.

There were upward of eighty delegates in attendance, representing 134 votes. The several sessions of the convention were held in the banquet hall of the hotel. Because of the large amount of business to be transacted, it was necessary to hold night sessions. At the opening meeting the delegates were addressed by James H. Preston, Mayor of Baltimore, who cordially welcomed the visitors. A charter offered by the American Federation of Labor was voted upon and accepted. At the afternoon session on Tuesday the delegates were addressed by Andrew Furuseth, International President of the Seamen's Union, who told of the labor conditions existing in the Navy and War Departments. The reading of the treasurer's report finds the organization on a sound financial basis.

On Wednesday evening, the delegates and their friends were entertained by local association No. 5 at its rooms on Baltimore St., and a pleasant evening was spent. The entertaining feature was the smoker on Thursday evening tendered to the convention by the Supplymen. There was a first-class vaudeville show, and pipes and tobacco were distributed to the auditors. On this evening the ladies were escorted to Ford's Theater.

The election of national officers resulted as follows: William S. Brown, Buffalo, N. Y., president; Thomas L. Delahunty, New York City, first vice president; John S. Fisher, Galveston, Tex., second vice president; William H. Hyman, Baltimore, Md., third vice president; George A. Grubb, Chicago, Ill., scretary; Albert L. Jones, Detroit, Mich., treasurer; William J. DuBois, Charles S. Follett, Fred H. Krueger, John S. Fisher and Charles N. Sheplar, form the executive committee. William Kelly was chosen for the board of trustees, and C. N. Vosburg was the installing officer.

The Supplymen elected its officers as follows: George F. Monroe, Garlock Packing Co., president; J. J. Cizek, the Leslie Co., vice president; Charles A. Wilhoft, New York Belting and Packing Co., secretary-treasurer. It was decided to leave the selection of the next convention city to the discretion of the executive committee.

January Meeting of the A. I. & S. E. E. and A. I. E. E. at Pittsburgh

The regular monthly meeting of the Pittsburgh Section, Association of Iron and Steel Electrical Engineers, was held at the Hotel Chatham, Pittsburgh, on Saturday evening, Jan. 18, jointly with a meeting of the local section of the American Institute of Electrical Engineers. Dinner was served before the meeting.

With Chairman C. A. Menk of the association and F. E. Wynne of the institute presiding, the meeting was opened with a paper by R. A. McCarty, engineer, Westinghouse Electric and Manufacturing Co., on "Methods of Power-Factor Correction." An abstract of this paper will appear in an early issue of *Power*.

Under the title, "A General Description of the Electrical Installation at the McDonald, Ohio, Works," B. A. Cornwell and B. W. Gilson, of the Carnegie Steel Co., presented an account of the transmission line, substation and distribution system at this new plant. Power is generated at the company's Ohio works, five miles distant, in a plant containing 18,000 kw. in gas-engine-driven 25-cycle alternators, at 6600 volts. It then passes through three 8000-kv.-a. oil-insulated self-cooled transformers and is stepped from 6600 to 44,000 volts. These transformers can carry the load on two units connected in open-delta in case one is taken out of service. The transmission line carries two three-phase circuits of No. 0000 wire on steel towers to a substation at the McDonald works, where the voltage is reduced from 44,000 to 6600, for roll and roll-train motors and motor-generator sets, and to 220 volts for other motors. The total line loss at full load is about 4 per cent.

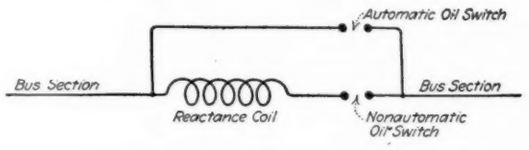
When completed, this plant will contain the following mills:

No.	Name	H.P. Main Motor	Speed Variation Above or Below Synchronism Per Cent.
1	18-in. band	2,500	20
1	8-in. bar	1,000	10
1	10-in. bar	1,500	20
1	14-in. bar	2,500	20
1	12-in. hoop	2,500	20
2	10-in. hoop	3,000	20
2	8-in. hoop	2,000	10
9		15,000	

At present only the 18-in. band mill is running, and the others are scheduled for completion at the rate of one every two months.

Opening the discussion, G. C. Hecker, of the Duquesne Light Co., asked why two circuit-breakers in series are used at each end of the transmission line and what the relay arrangement is. Mr. Gilson replied that two are used for safety reasons; that each has its own equipment of current transformers, overload relays and control panel, the relay setting for one being slightly higher than the other. There is no interlocking between the circuit-breakers; one is used for normal operation, and the other is held in reserve. No reactance coils are used.

E. Friedlander, electrical superintendent of the Carnegie Works at Bessemer, suggested the advisibility of connecting a reactance across one circuit-breaker which should be the



first to open, thus dividing the current to be interrupted due to a short-circuit between both breakers, instead of requiring the first one opening to rupture the entire current. On the other hand, gas-engine-driven alternators will not deliver the heavy short-circuit current, that a turbo-generator would, on account of their less inertia. He considered it better practice to install reactances between the large motors and the high-tension bus in order to prevent trouble on one motor tripping the main circuit-breakers.

Mr. Hecker said that the Duquesne Light Co. used a reactance in series with a nonautomatic oil switch between sections of its station busses; the sections were also tied by an automatic overload breaker as in the figure, so that trouble on one section would automatically cut in a reactance between that section and adjoining ones; if the trouble did not speedily clear itself, the operator would open the nonautomatic breakers and isolate the section.

Many favorable comments on the arrangement of the McDonald plant were made by those who had visited it, and it was hoped that the association might visit it in a body.

Coal Shortage in New England Still Serious

The critical shortage of coal in New England has precipitated some drastic action by Fuel Administrator Storrow. What Boston hails as a master stroke by the Fuel Administrator is the purchase with his own credit of considerable coal. After the purchase he secured priority for its shipment from Mr. McAdoo, so that this coal may now come direct to Boston and there be distributed by the Fuel Administration.

Five minutes spent in that part of the State House used by the Fuel Administration would convince even the most doubting that the Garfield order created more than havoc in and around Boston. Despite the fact that there is a considerable number in the personnel of the administration, the lobbies and halls and waiting rooms were crowded with protesting and exemption-seeking fuel users.

Mr. Storrow is convinced that there is no possibility of giving New England coal enough by means of rail transportion, as the requirements are 130,000 tons per week and half of this amount is not arriving and cannot be made to arrive over the already overloaded rails. As a matter of fact this amount is not now arriving either by rail or by water or both.

The charge is now made that during all last year there never was a shortage of boats to carry coal to New England when coal was available at the loading piers at Hampton Roads. It is further said that while the Government did take over some ships of the fleet used to carry coal to New England, those boats left were often lying idle for want of coal at the loading points. It is further reported that some of the transportation companies claim that there were times during the scarcity of coal when their tugs were hunting for barges to tow. It is quite generally conceded that inasmuch as two-thirds of the supply for New England must come by the water routes, the fleet should be increased so that a considerable more than two-thirds of the coal may come in by water and thus relieve the already seriously congested railroads. The charge is made further that great quantities of coal were sent to the West and Northwest after the lakes had frozen over and there was no means of conveying the coal by the water routes into the Northwest region. This has tied up thousands of cars loaded with coal, which have remained, as many yet remain, east of the Northwest region. Mr. Storrow has managed to head some of these cars New Englandward, but most of the coal still lies on the tracks where it was stalled weeks, perhaps months, ago, according to the latest report.

The all-rail shipment of coal ties up, it would be difficult to tell, how many cars. Because of all-rail shipment, the cars are compelled to travel many times farther than the distance between the mines and tidewater, as they do under normal conditions.

Rhode Island is in a rather serious condition, owing to the fact that the rail deliveries of coal are very low and because ice has repeatedly closed Narragansett Bay. The Navy has been busy breaking the ice and towing delayed barges to their docks.

Getting a perspective of the whole situation by viewing it here and viewing it there, one is convinced that it will be a long, long time before the rail and the water transportation systems, together with the fuel requirements and coal reserves, will again become normal.

American Society of Heating and Ventilating Engineers

The 24th annual meeting of this society, held Jan. 22, 23 and 24, at the Engineering Societies Building, 29 West 39th St., New York, proved to be one of the best in the history of the society. President J. Irvine Lyle congratulated the members on the interest that was manifested by the large attendance, even though many members living at a distance who had expected to be present, were unable on account of difficulties of traveling due to unusually severe winter weather, while a large number of the society's most active members, represented by the 38 stars of the society's service flag, had gone into the naval and military service of the country, and on the very eve of the meeting unusual demands had been made on the services of members engaged in every branch of the heating business by the extraordinary limitations placed on fuel consumption.

The Membership Committee's report showed that with all allowances, the net increase of the society's membership was 74; that would bring the membership up to about 800. A communication from the National District Heating Association stated that it had decided not to hold its meeting in June and therefore it would not be able to consolidate technical sessions with those of the A. S. H. and V. E. summer meeting of the present year. The committee working in conjunction with a committee of the Navy Department on the ventilation of battleships and submarines reported that progress had been made that will almost revolutionize the designs of some classes of ships. Committees working in conjunction with the Council of National Defense on improvement of the sanitary condition of factories engaged in the manufacture of munitions, and also the other committees that had been appointed to coöperate with various departments of national defense, reported progress. The report of the auditing committees showed that the society is in good financial condition and the recommendation was unanimously adopted that during the period of the war all members in the service of the army or navy shall have dues remitted without curtailment of privileges.

The Committee on Research Bureau recommended that a director of research work in the science of heating and ventilation should be appointed to take charge of technical investigations in behalf of the society in conjunction with a department of Government or institution of learning provided the director is selected in a manner acceptable to the society after provision is made for his salary by popular subscription providing for not less than $2500 nor more than $3600 per annum. After full discussion the subject was referred to the council with power to carry out the recommendations if found practicable.

Officers elected for the ensuing year were: President, Fred. R. Still, secretary and chief engineer of American Blower Co., Detroit, Mich.; first vice president, Walter S. Timmis, consulting engineer, New York City; second vice president, Dr. E. Vernon Hill, Department of Health, Chicago, Ill. Treasurer Homer Addams and Secretary Casin W. Obert were reëlected.

The Drying Session, Tuesday evening, Jan. 22, was occupied by an address by H. C. Gore, chemist of Department of Agriculture; a paper on "High Temperature Drying," by B. S. Harrison, and a paper by W. H. Carrier on "The Temperature of Evaporation."

Wednesday afternoon's session, devoted to fuel conservation, was enlightened by an address by Prof. L. P. Breckenridge, representing the United States Fuel Administrator. Professor Breckenridge's address was replete with interesting information on the subject of coal distribution, production and consumption, graphically illustrated by lantern slides. George W. Martin presented a paper on "Fuel Conservation," in which he stated that "the recent drastic order of Fuel Commissioner Garfield has brought to the attention of everyone the fact that serious shortage exists in the supply of coal available for domestic and power purposes."

A paper on "Economy in Fuel" was presented by Perry West, and one on "Fuel Conservation" by William M. Mackay. Wednesday afternoon's session was rounded out by a free discussion on the subject of different methods of economizing fuel and was made especially interesting by interchange of personal experiences of those present with a view of sounding the practicability of regulation of domestic fuel supply per room or per capita. The results of these comparisons showed wide variations and that it would be extremely difficult to devise a system of fuel apportionment for American residences without working serious hardship upon those whose homes could only be adapted to an average supply of fuel at great sacrifice to the owners, while to many a stringent average would be a surfeit.

"What We Do and Don't Know About Heating" was the subject of a paper by Prof. John R. Allen read at the Wednesday evening's session which will be printed in a future issue of *Power*. The report of the Committee on Code for Testing Low Pressure Boilers was received and discussed and the code was adopted as recommended in the report of the committee that was printed in the October issue of the society's Journal. The committee was continued to revise and interpret the code as may be required.

The fifth session, held Thursday morning, was given over to Furnace Heating and included the delivery of an address by D. R. Richardson, and papers: "The Engineering of Warm-Air Furnace Heating," by M. W. Ehrlich; "Answering Fuel Needs With a New Gas Heating System," by G. S. Barrows; and "Dust—Its Universality, Elimination and Conservation," by E. R. Knowles.

The professional sessions were closed Thursday afternoon by papers: "The Preservation of Hot-Water Supply Pipe," by F. N. Speller and R. G. Knowland; "The Relation of Hot-Water Service Heating to Various Types of Buildings," by H. L. Alt.; "Calculations and Analysis of a Compound

Gravity Low-Pressure Hot-Water System," by A. J. Wells; and "Measurements of Low-Pressure Steam Used for Heating the Buildings of the University of Michigan," by J. E. Emswiler.

SOCIAL ENTERTAINMENT

The programme for ladies included assemblage with the ladies' reception committee in the main lobby of the Engineering Building and luncheons and thoater parties on Wednesday and Thursday, and on Thursday evening the twenty-fourth annual meeting was brought to a close by members, guests and ladies participating in a dinner and dance at the Hotel Astor.

Boston Welcomes President Main

The Boston Section of the American Society of Mechanical Engineers gave a reception to Charles T. Main, of Boston, the newly elected president of the society, on Tuesday evening, Jan. 22. The reception was held at the Engineers' Club and was preceded by a dinner, arranged by the section committee, Harry Ashton, W. G. Starkweather and F. L. Fairbanks.

Among those who spoke was John R. Freeman, of Providence, who reviewed some of the engineering achievements of Mr. Main. Mr. Freeman emphasized the Pacific Mills (textile) designed by Mr. Main, also the part the new president played in the Big Creek water-power development. Prof. Lionel S. Marks, of the Massachusetts Institute of Technology, recalled the illustrious presidents the society had had and who were New Englanders; chief among these were E. D. Leavitt, John R. Freeman and Dr. Ira N. Hollis. Prof. George C. Whipple, president of the Boston Society of Civil Engineers, spoke of Mr. Main's work in that field, and Prof. D. C. Jackson, of the Massachusetts Institute of Technology, acknowledged the indebtedness of the electrical engineers to Mr. Main for his assistance in the development of the electrical industry.

Calvin W. Rice, secretary of the American Society of Mechanical Engineers, told of the society's work in the war, claiming that considerable was yet to be done and urging upon the engineers to give their services to the Government. R. A. Hale, of the Essex Co., Lawrence, emphasized the value of the civic services rendered by Mr. Main to his home city. Desmond Fitzgerald, one of Boston's old and distinguished citizens, was most entertaining in his portrayal of Mr. Main's life, so full of experience, so simple and so accomplished.

Those in attendance then listened to W. R. Balch, war editor of the Boston *Transcript*, tell of events in Europe during the war. Mr. Balch laid particular stress upon the great social, moral and economic changes sure to come out of the war. Unfortunately he had to cut his address to a half hour on account of Fuel Administrator Storrow's order closing all public places at 10 o'clock.

Proposed Law Allows Expansion of Municipal Power Plants

The borough officials of Madison, N. J., in coöperation with neighboring municipalities, have drafted two interesting bills to be presented at the present session of the State Legislature, covering extended powers for municipal-lighting plants. These bills relate to two distinct phases of station operation, the first dealing with service combination between two or more municipal plants for greater efficiency, particularly with reference to fuel conservation, and the second to cover the sale of electric energy generated by municipal stations outside of the city or borough limits. These measures are the result of recent decisions of the Board of Public Utility Commissioners in holding that such proposed conditions of operation would make the plants subject to the jurisdiction of the board, to be considered under the head of regular public utilities.

The first-noted bill provides for the granting of authority for municipal plants in neighboring sections to coöperate and combine, where desired, for the rendering of proper service. Under this law a municipal plant would be privileged to furnish service to another community, and without falling within the domain of the state utility board in the features of bond issues, franchises, rates for light and power, etc.

As a concrete example of operation under this law the boroughs of Madison and Chatham desire to combine the service of the municipal electric plants of each municipality. In this it is proposed that the larger plant, located in Madison, furnish service for the late afternoon and night load, when the demand is heavy, in both boroughs, covering both street and private lighting, while the plant at Chatham would be employed at other periods of the day and under light-load conditions. The systems would be tied in together and the plants operated practically under one head.

By the other measure it is proposed to grant municipalities the right to sell electric current for light and power purposes outside of the municipal limits, all lines and equipment beyond the city or borough limits to be under the control of the Board of Public Utility Commissioners, but exempting the electric stations from this jurisdiction, as well as the furnishing of service strictly within the boundaries of the particular municipality.

The Madison power plant recently endeavored to supply electric energy in Chatham Township, but was compelled to discontinue service or become a regular public utility, in accordance with a ruling of the utility board. The service in this section is now being supplied by the Morris & Somerset Electric Company.

Federal Funds for Vocational Education

Recent Federal grants of money for vocational education totaling more than $240,000 have been allotted by the Federal Board for Vocational Education to eight states, each of which has complied with the terms of the Smith-Hughes law and has agreed that a sum of money equal to the amount of its grant shall be publicly raised by the state or local community. These states are Connecticut, Idaho, Illinois, New Hampshire, North Dakota, Missouri, Maryland and Vermont. The payments of Federal money are made through state boards for vocational education and are divided into three general classes—money allotted on the basis of rural population for the salaries of teachers, supervisors or directors of agricultural subjects; money allotted on the basis of urban population for the salaries of teachers of trade, home economics and industrial subjects; and money allotted on the basis of total population for the maintenance of teacher-training courses in all subjects. There are 47 states now enjoying the benefits of the Smith-Hughes act. Rhode Island has not yet accepted its provisions.—*Commerce Reports.*

Coal (?) Fifty-Five Cents a Ton!

The inventive genius of a people is said to thrive best in an atmosphere of pressing necessity. This fact possibly accounts for the amazing discovery—according to a brief newspaper note—of a method of making coal out of ashes. Making ashes out of coal is a comparatively simple and common performance. Reversing the process is remarkable, not to say miraculous, Yet it is none the less feasible, if we are to believe the statements of the secretary-treasurer of the George W. Loft Co., New York City. Says he:

Our firm has been burning 55-cent coal for some time. We take the ashes after the furnace is done with them—just plain, ordinary ashes—and your five gallons of kerosene over about a ton of them. Then we feed the mixture into the furnace. From five gallons of oil, at 1c. a gallon, we get as much steam as we could from a ton of $8 or $10 coal.

If five gallons of kerosene, containing a total of about 700,000 B.t.u., will, when mixed with ashes, produce as much steam as 2000 lb. of coal, containing approximately 27,000,000 B.t.u., there are, in the despised ashcan, virtues of which none of us ever dreamed!

Poster Competition

Under the Auspices of the
Smoke and Dust Abatement League of Pittsburgh

1. The Smoke and Dust Abatement League desires a poster design which will express in simple form the relation of smoke abatement to fuel conservation.

2. The Committee in charge of the competition offers the following outline of the smoke abatement problem as a basis for poster ideas:

During 1917 some 500,000,000 tons of bituminous coal were consumed in the United States. Of this amount about 20 per cent., or 100,000,000 tons, were lost through imperfect combustion—the visible sign of which is black smoke.

Black smoke is an indicator of waste and inefficiency. A streamer of black smoke is the black flag of a pirate confiscating a part of the nation's resources.

Black smoke in time of peace means a great waste and a pollution of the atmosphere, which destroys building materials, retards the growth of vegetation, cuts off sunlight and daylight, prolongs fogs, is injurious to comfort and health, and is costly both to the smoke maker and to the public. In time of war it means all of that and more. Coal is a sinew of war. Coal is a food for fighters, and he who unnecessarily reduces the country's available supply curtails the nation's energy in the great industrial conflict.

The elimination of smoke requires knowledge, care, attention and some investment of money. There is no use minimizing these requirements. They are not too much to ask for the benefits resulting.

The dividends on the investment of knowledge, care and attention are self-respect, a citizen doing his duty by his fellows, and a better place in which to live and work. If the investment of money has been made with the same caution and advice as other investments, the dividends in money are nearly always sure, adequate and may be as large as speculative ventures.

3. The competition is open to all residents of the Greater Pittsburgh District.

4. The design is limited to three colors and black.

5. The size of the work is to be 15 x 24 in.

6. The seal of the league—the seal of the City of Pittsburgh with the inscription "Smoke and Dust Abatement League of Pittsburgh" encircling it—is to appear in the design. The seal is to be about three inches in diameter.

7. The designs must be handed in before noon on Feb. 16, 1918.

8. The designs are to be left at the Civic Club of Allegheny County, sixth floor, Keenan Building.

9. The name and address of contestant must be placed on the back of design.

10. The prizes are to be as follows: First prize, $50; second prize, $20; two prizes, $5; four prizes, $2.50; ten prizes, $1.

11. The first four prize-winning designs are to become the sole property of the league upon payment of the prize money. The league is to have the privilege of exhibiting all of the poster designs.

12. The judges for the competition will be announced at a later date.

13. Additional information concerning the competition may be secured from the secretary of the Smoke and Dust Abatement League, John O'Connor, Jr., Mellon Institute, University of Pittsburgh; Telephone, Schenley 897.

Committee: John O'Connor, Jr., Chairman; Mrs. Isobel A. Bowers, Miss H. Marie Dermitt, Mrs. William D. Hamilton, C. J. Taylor.

Obituary

Lieut. Gordon D. Cooke, who, prior to entering the service of the country, was a member of the field-service department of the McGraw-Hill Co., died of pneumonia at the base hospital, Fort Bliss, Tex., on Jan. 10. He was a graduate of the University of Michigan and was 24 years old.

Personal

B. J. Denman, formerly chief engineer of power plants of the Detroit Edison Co., and for the last few years vice president and general manager of the Tri-City Railway and Light Co., Davenport, Iowa, has been elected president of the company.

Miscellaneous News

A Steam Pipe, used for an exhaust through the firebox, broke and caused an explosion in the boiler room of the Alamito dairy, at Omaha, Neb., on Jan. 11, killing the fireman.

A Tube Blew Out of one of the boilers at the power house at Fayette station, Connellsville, Penn., on Jan. 13, painfully scalding five men and crippling the West Penn power system for an hour.

A Large Furnace Boiler Exploded in the subcellar of the new building occupied by Bowles lunch on Main St., Buffalo, N. Y., on Jan. 21, killing the engineer and turning the furnace room into a mass of débris. The force of the explosion shook the building and threw patrons in the lunch room into a panic. The boiler was a new one, having been installed a few weeks ago. The cause of the explosion is unknown.

Red Cross Wants Tracing Cloth—To help meet the enormous problem of securing a sufficient quantity of white goods for the manufacture of surgical dressings, the Red Cross is asking architects, manufacturers and draftsmen to contribute their discarded tracing cloth. If anyone having such material will call up one of the large laundries of his city, he will find them glad to send for such cloth as he can give them. The laundries will wash and bleach the material and forward it to its proper destination.

A Boiler Explosion at the Wishkah shingle mill, Aberdeen, Wash., on Jan. 18, killed one man, seriously injured another, and completely wrecked a portion of the plant. Both men were thrown fifty feet by the explosion, their bodies falling into the river, and bricks surrounding the boiler were thrown more than 300 yards. The concussion was felt in stores 500 yards away. A piece of the boiler weighing several hundred pounds was hurled through the air for 150 yards. The cause of the explosion is unknown.

The Navy Department Announces that men will be soon selected for aviation service. Men of suitable qualifications who report now to the Navy recruiting offices are eligible for examination for commissions and ratings. The rates of pay and duties assigned in this aviation work in the Navy will make this opportunity highly attractive to mechanical engineers and to draftsmen, mechanics and others who are experienced in gasoline-engine design or operation. Full information may be obtained at any Navy recruiting office.

Merger of Electrical Plants—The Mohawk Gas Co., understood as being controlled by General Electric Co. interests, has filed intentions with the Public Service Commission and the Schenectady County Clerk a plan to merger all plants that generate electric power from the Hudson River west to Herkimer County, which would include the Spier Falls and Schaghticoke hydro-electric plants and which would indirectly control the electric-power supply of the City of Albany and the cities and towns of Albany, Rensselaer, Fulton, Schoharie, Montgomery County and part of Herkimer County. Application has also been filed with the Public Service Commission to combine the Schenectady Illuminating Co., Schenectady Power Co. and the Mohawk Gas Co., under the name of the Mohawk Gas Co.

Power-Plant Courses in Wisconsin—The University of Wisconsin, University Extension Division, is now prepared to give, by correspondence, a course in practical hand firing, which will take up methods of making a good fire, fuel supply, tools, size of coal, effect on smoke, boiler stresses, effect of clinker, draft regulation and feed water problems, and the care of boilers. The University is having considerable success with this course, particularly in plants which are face to face with coal shortage. The following steam-engineering courses have been prepared for firemen and engineers who desire to increase their efficiency and prepare for promotion and increased earnings: Steam Boilers, Part I; Steam Boilers, Part II; Steam Engines, Part I; Steam Engines, Part II; Heat—Part I, Principles; Heat—Part II, Application, Fuel, Refrigeration, Heating and Ventilation. Those desiring further information should address the University Extension Division, University of Wisconsin, Madison, Wis.

Massachusetts Teaches Power-Plant Economics—In the hope of preventing the great wastage of fuel that occurs in steam-power plants, due to inefficient management more than to equipment or to the ability of the plant to use the fuel efficiently, the State Board of Education of the Commonwealth of Massachusetts has organized a class in power-plant economics, the first lecture being Monday evening, Feb. 4, at Room 109, State House, Boston. The idea of the classes is the dissemination of easily understood information of how to obtain the full worth of every pound of fuel used in the industry. J. A. Eames, instructor in mechanical engineering, in the Department of University Extension of the Massachusetts Institute of Technology, will give the course, which will be in the form of lectures and discussion on modern power-plant problems. The subjects include power-plant location, boiler plans, equipment, methods of firing, arrangement of heating surfaces, and specifications for the purchase of coal by contract. There is no charge for tuition, but the student is expected to buy his textbooks.

Business Items

The Liberty Manufacturing Co. has removed its offices from Susquehanna St. to the Frick Building, Pittsburgh, Penn.

The Elliott Co. has disposed of its office building on Susquehanna St., and taken offices in the Frick Building, Pittsburgh, Penn.

The Esterline Co., Indianapolis, Ind., announces the appointment of the F. R. Jennings Co., 616 Ford Building, Detroit, Mich., as its sales representative for graphic instruments for the state of Michigan. Mr. Jennings will handle the entire state for the Esterline Co., with the exception of the northern peninsula, which is taken care of by the Milwaukee office.

The National Tube Co. is sending out an interesting circular illustrating seven instances of the remarkable ductility of "National" pipe. In Biblical times seven was a number signifying completeness; the furnace in which the three Hebrew children were placed was heated sever times hotter than usual. Also in profane history we read of the Seven Wonders of the World, the Seven Wise Men of Greece, etc. Therefore, out of the many instances of the ductility of "National" pipe seven was the number appropriately chosen for illustration.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Clearfields....	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets..	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.
*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$6.50—6.75
Buckwheat ..	4.30—5.00	2.75	5.50—6.00	6.00—6.25
Rice	3.75—3.95	2.20	4.50—5.00	4.50—5.00
Barley	3.25—3.50	1.95	4.00—4.25	3.25—3.75
Boiler	3.50—3.75	2.20	.....	.....

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		Independent
	Jan. 31, 1918	One Year Ago	Jan. 31, 1918	One Year Ago	One Year Ago
Buckwheat ...	$3.15—3.75	$2.00	$3.75	$2.90	$4.15
Rice	2.65—3.65	1.25	3.65	2.15	3.35
Boiler	2.45—2.85	1.10	3.55	2.00	....
Barley	2.15—2.40	1.00	2.40	1.90	2.35
Pea	3.75	2.80	4.65	3.70	....
Culm	....	....	....	....	1.25

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 31. 1918	One Year Ago	Jan. 31. 1918	One Year Ago	Jan. 31. 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.35-2.75
2-in. lump..	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Steam egg ...	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Russellville—The Alabama Power Co. is having plans prepared for the extension of its transmission line from here to Sheffield and Muscle Shoals. W. N. Walmsley, Birmingham, Gen. Mgr.

Conn., Norwich—City plans to install new electric equipment including a 300-kw. turbine with a 500-hp. boiler in its gas and electric plant. Estimated cost, $200,000.

Conn., Thamesville—(Norwich P. O.)—The Eastern Connecticut Power Co. is having plans prepared by H. M. Hope Eng. Co., Eng., 185 Devonshire St., Boston, for the erection of a power plant. R. W. Perkins, Treas. Noted Dec. 4 under "Norwich."

Ga., Americus—City plans to build an electric-lighting plant. J. B. Ansley, City Engr.

Ga., Savannah—City is considering a proposition made by the Savannah Lighting Co. to install electrical turbine pumps in its water department.

Kan., Chardon—City voted to issue $25,000 bonds for the erection of an electric-lighting plant.

Mich., Menominee—The Menominee Electric Manufacturing Co. will soon award the contract for the erection of four 1-story additions to its plant. Estimated cost, $60,000.

Miss., Wiggins—City plans to improve its electric-lighting and water-works system.

Mont., Redstone—City plans to rebuild its electric-lighting plant.

N. J., Camden—Warren Webster & Co. has notified the Public Utility Commissioners of an increase in its capital stock from $150,000 to $450,000; the proceeds will be used to build additions and improvements to its plant.

N. Y., Brooklyn—The Bureau of Supplies and Accounts, Navy Department, Wash., will soon receive bids for furnishing at Navy Yard, Brooklyn, under Schedule No. 1669, 12-in. desk and bracket fans; under Schedule No. 1670, 630,000 ft. incandescent lamp cord, 11,500 ft. rubber-insulated, lead-covered wire, duplex, single-conductor, rubber covered wire, 120,000 ft. rubber-insulated telephone wire and 130,000 ft. twin conductor wire; under Schedule No. 1671, leaded and armored, interior-communication cable and 145,000 ft. plain, single-conductor wire.

N. Y., Brooklyn—The Interborough Rapid Transit Co., 165 Bway., New York City, plans to build a 1 story, 50 x 100 ft. transformer station on Livonia Ave. Estimated cost, $40,000. G. H. Pegram, New York City, Ch. Engr.

N. Y., Buffalo—The Oldman Boiler Works, 38 Illinois St., is in the market for new equipment including punching machinery, blowers, motors, a 25-ton crane and riveting machinery for its boiler shop.

N. Y., New York—The Weyant Electrical Co., 111 Broad St., has increased its capital stock from $5000 to $15,000; the proceeds will be used to build additions and improvements to its plant.

Okla., Bartlesville—The Crystal Ice and Storage Co. plans to rebuild its plant which was destroyed by fire.

Okla., Bristow—City plans an election soon to vote on $25,000 bond issue for an electric-lighting plant. T. B. Gibson, City Clerk.

Okla., Prague—City plans an election to vote on a bond issue for improvements to its electric-lighting plant.

Penn., Philadelphia—The Philadelphia Electric Co. plans to build a large power house on Beach and Palmer Sts. Estimated cost, $8,000,000. A. K. Coe, Secy.

Tex., San Angelo—The San Angelo Ice and Power Co. plans to expend about $10,000 in improvements to its plant. A. L. Lair, Mgr.

Va., Suffolk—The Virginia Ry. and Power Co. plans to issue $950,000 bonds; the proceeds will be used for extensive improvements to its plant, including the erection of an electric transmission line from here to Petersburg.

Wash., Davenport—The Washington Water Power Co. plans to build a 65-mile high tension transmission line from its Long Lake plant in Lincoln Co. to a point 12 miles south of Odessa. Estimated cost, $100,000. C. F. Uhden, Spokane, Ch. Engr.

W. Va., Switchback—The Appalachian Power Co. plans to rebuild its central power plant which was recently destroyed by fire.

W. Va., Wheeling—The Beech Bottom Coal Co. plans to rebuild its power station, which was destroyed by fire. Loss, $40,000.

Wis., Beaver Dam—The Wiscinsin Power, Light and Heat Co. plans to build a transmission line here. J. D. Roberts, Supt.

Wis., Madison—The Di-Electric Manufacturing Co., incorporated with $40,000 capital stock, plans to build a plant. E. W. Smythe, Jr., Vroman Blk., and E. K. Frautschi, incorporators.

B. C., Nelson—The Swanetta Power Co., incorporated with $300,000 capital stock, plans to build a large hydro-electric plant on the Pend d'Oreille River, south of Nelson.

Ont., Stayner—J. Knox is in the market for a 30-hp. and 3-hp. 220-volt, 60-cycle, 3-phase A.C. motor.

Que., Montreal—The Canadian Pacific Telegraph Co., 4 Hospital St., is in the market for a 25-volt, 60-ampere motor generator. W. D. Nell, Supt.

Sask., Yorkton—A. M. McNicol, Box 526, is in the market for a 250-gallon vertical centrifugal submerged pump and a vertical 40-hp. A. C. 3-phase, 60 cycle, 550-volt, direct drive motor.

Prices—Materials and Supplies

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

ELECTRICAL SUPPLIES

KNIFE SWITCHES—Following are net prices each in cities named for knife switches mounted on slate base, front connected, punched clip type, 250 volts:

	30 Amp.	60 Amp.	100 Amp.	200 Amp.
D. P. S. T. fuseless	$0.52	$0.93	$1.90	$3.42
D. P. S. T. fused	.81	1.37	2.70	5.14
D. P. D. T. fuseless	.88	1.52	3.42	5.70
D. P. D. T. fused	1.67	2.58	5.62	9.88
T. P. S. T. fuseless	.78	1.40	2.86	5.14
T. P. S. T. fused	1.22	2.05	4.18	7.70
T. P. D. T. fuseless	1.37	2.35	5.24	8.82
T. P. D. T. fused	2.68	4.13	8.99	15.80

Lots $25 and more, list.

FUSES—Following are net prices of 250-volt inclosed fuses each, in standard packages, in cities named:

0-30 amperes	$0.11¼ each	110-200 amperes	$0.90 each
31-60 amperes	.15¾ each	225-400 amperes	1.62 each
61-100 amperes	.40 each		

FUSE PLUGS (MICA CAP) PER 100

0-30 amperes.. 4c. each in standard package quantities (500)
0.30 amperes.. 5c. each for less than standard package quantities (500)

SOCKETS, B. B. FINISH—Following are net prices in cents each in standard packages:

⅛-IN. OR PENDANT CAP			⅜-IN. CAP		
Key	Keyless	Pull	Key	Keyless	Pull
22.10c.	21.00c.	42.00c.	27.30c.	26.20c.	46.20c.

Note—Less than standard package quantities, 15% off list.

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

ATTACHMENT PLUGS—Price each, in standard packages:

		Standard Package
Hubbell porcelain	$0.21	250
Hubbell composition	.12	50
Benjamin swivel	.12	..
Current taps	.35	50

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$21.50
No. 16 cotton twisted	29.00
No. 18 cotton parallel	24.00
No. 16 cotton parallel	36.00
No. 18 cotton reinforced heavy	28.50
No. 16 cotton reinforced heavy	39.40
No. 18 cotton reinforced light	24.00
No. 16 cotton reinforced light	32.00
No. 18 cotton Canvasite cord	21.75
No. 16 cotton Canvasite cord	32.00

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York:

No.	Solid, Single Braid	Solid, Double Braid	Stranded, Double Braid	Duplex
14	$10.50	$12.50	$15.00	$23.50
12	14.23	16.92	19.48	32.25
10	16.92	22.83	25.81	45.00
8	27.65	31.40	35.50	61.00
6	....	....	56.00	....
4	....	....	76.40	....
2	....	....	112.45	....
1	....	....	152.26	....
0	....	....	182.90	....
00	....	....	223.60	....
000	....	....	271.24	....
0000	....	....	332.40	....

COPPER WIRE—Prices per 1000 ft. for rubber-covered wire in following cities:

	Denver			St. Louis			Birmingham		
No.	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$10.90	$15.15	$27.25	$11.30	$13.37	$26.08	$15.00	$17.90	$36.80
10	23.70	27.05	49.35	23.16	26.34	....	29.00	34.30	67.60
8	33.60	37.35	74.45	32.32	35.96	....	39.90	46.85	....
6	....	57.15	....	....	62.92	....	58.95	74.60	....
4	....	81.70	....	....	88.20	....	97.20	106.55	....
2	....	121.80	....	....	127.38	....	154.50	163.00	....
1	....	158.50	....	....	167.80	....	197.45	209.50	....
0	....	189.40	....	....	192.00	....	276.00	285.50	....
00	....	298.05	....	....	245.78	....	317.00	330.00	....
000	....	362.15	....	....	300.00	....	414.40	428.00	....
0000	....	448.50	....	....	364.32	....	508.00	516.00	....

LOOM—Price per 100 ft., in coils:

Ft. in Coil			Ft. in Coil	
¼	250	$2.25	¾	150	$7.00
⅜	250	3.50	1	100	10.00
½	200	4.50	1¼	100	12.00
⅝	200	5.75	1½	100	15.00

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per unit for elbows and couplings:

	Conduit		Elbows		Couplings	
In.	Enameled	Galvanized	Enameled	Galvanized	Enameled	Galvanized
½	$69.70	$74.80	$0.1672	$0.1786	$0.0616	$0.0658
¾	92.00	98.90	.22	.235	.088	.094
1	136.00	146.20	.3256	.3478	.1144	.1222
1¼	184.00	197.80	.4185	.4496	.1581	.1698
1½	220.00	236.50	.558	.5994	.1953	.2098
2	296.00	318.20	1.023	1.10	.2604	.2797
2½	468.00	503.10	1.674	1.80	.372	.3996
3	612.00	657.90	4.464	4.79	.558	.5994
3½	763.60	818.80	9.86	10.59	.744	.7992
4	926.50	991.90	11.39	12.23	.93	.999

Standard lengths rigid, 10 ft. Standard lengths flexible, ½ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

LOCKNUTS AND BUSHINGS—Following are net prices in standard packages, which are: ½-in., 1000; ¾- to 1¼ in., 100; 1½- to 2-in., 50:

	Locknuts Per 100	Bushings Per 100	Flexible Conduit Box Connections Per 100
½	$1.02	$1.68	$5.62
¾	1.75	4.00	7.12
1	3.00	6.15	10.50
1¼	5.00	8.20	15.00
1½	7.50	10.25	22.50
2	10.00	16.40	30.00
2½	12.30	24.60	67.50

ARMORED CABLES AND BOX CONNECTORS—Following are net prices per 1000 ft. cable and standard package of 100 box connectors in single and double strip:

Wire Gage	Twin Conductor Cable	Twin Conductor Connectors	Three Conductor Cable	Three Conductor Connectors
14	$70.00	$4.50	$103.50	$4.50
12	101.25	4.50	127.50	4.50
10	138.75	4.75	176.25	4.75
8	176.20	5.75	247.50	6.00
6	277.50	6.25	362.40	7.50
4	431.25	7.50	....	....

LAMPS—Below are present quotations in less than standard package quantities:

	Straight-Side Bulbs			Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.33	100	75	$0.70	$0.75	50
15	.30	.33	100	100	1.10	1.15	24
25	.30	.33	100	150	1.65	1.70	24
40	.30	.33	100	200	2.20	2.27	24
50	.30	.33	100	300	3.25	3.35	24
60	.35	.39	100	400	4.30	4.45	12
100	.70	.77	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 net up allow a discount of 17% from list.

WIRING SUPPLIES—New York prices for tape and solder are as follows:

Friction tape, ½-lb. rolls	35c. per lb.
Rubber tape, ½-lb. rolls	45c. per lb.
Wire solder, 50-lb. pools	45c. per lb.
Soldering paste, 1-lb. cans	50c. per lb.

MISCELLANEOUS

HOSE—

Fire

	50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	40%

Air

	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.55	$0.30	$0.25

Steam—Discounts from list

First grade... 30% Second grade... 30-5% Third grade... 40-10%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 50% Best grade 20%
Standard 35%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	40%	35%
St. Louis	45%	40%
Chicago	30+10%	40+5%
Birmingham	35%	35%
Denver	40%	35%

RAWHIDE LACING—40%.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.77
Asbestos for high-pressure steam	1.54
Duck and rubber for piston packing	.88
Flax, regular	.66
Flax, waterproofed	.99
Compressed asbestos sheet	.99
Wire insertion asbestos sheet	1.21
Rubber sheet	.55
Rubber sheet, wire insertion	.88
Rubber sheet, duck insertion	.44
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided, and graphited, for valve stems and stuffing boxes	1.10
Asbestos wick, ½- and 1-lb. balls	.65 to .70

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure ..... 5% off

For low-pressure heating and return lines { 4-ply ..... 58% off; 3-ply ..... 60% off; 2-ply ..... 62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Chicago	St. Louis	Birmingham	Denver
Cup	7	5¼	6.1	8½	10
Fiber or sponge	8	6	6.4	15	15
Transmission	7	6	6.4	10	15
Axle	4½	4	3.3	3	5
Gear	4½	4½	6.5	5½	5½
Car journal	22 (gal.)	3½	4.6	5	5

COTTON WASTE—The following prices are in cents per pound:

	New York			
	Jan. 30, 1918	One Year Ago	Cleveland	Chicago
White	11.00 to 13.00	13.00 to 15.00	16.00	12.00 to 13.00
Colored mixed	8.50 to 12.00	10.00 to 12.00	12.50	10.00 to 12.00

WIPING CLOTHS—In Cleveland the jobbers' price per 1000 is as follows:

13¼ x 13¼ ..... $35.00 13¼ x 20½ $45.00

In Chicago they sell at $30@33 per 1000.

LINSEED OIL—These prices are per gallon:

	New York		Cleveland		Chicago	
	Jan. 30, 1918	1 Year Ago	Jan. 30, 1918	1 Year Ago	Jan. 30, 1918	1 Year Ago
Raw per barrel	$1.31	$0.96	$1.35	$1.00	$1.32	$0.98
5-gal. cans	1.41	1.06	1.50	1.10	1.45	1.08

WHITE AND RED LEAD in 500-lb. lots sell as follows in cents per pound:

	Red				White	
	Jan. 30, 1918		1 Year Ago		Jan. 30, 1918 Dry and In Oil	1 Yr. Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
25- and 50-lb. kegs	11.50	11.00	10.50	11.00	10.50	10.50
12½-lb. keg	11.75	11.25	10.75	11.25	10.75	10.75
100-lb. keg	11.25	11.50	11.00	11.50	11.00	11.00
1- to 5-lb. cans	13.25	13.00	12.50	12.50	13.00	12.50

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	30%	35%	40%*
Tinned	30%	35%	40%*

*For less than keg lots the discount is 35%.

Button heads, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York ..... $7.00 Cleveland ..... $5.85 Chicago $5.50

Coneheads, same sizes:

New York ..... $7.10 Cleveland ..... $5.95 Chicago $5.60

FIRE BRICK—Quotations on the different kinds in the cities named are as follows, f.o.b. works:

	New York	Chicago
Silica brick, per 1000	$50.00 to 55.00	$50.00
Fire clay brick, per 1000, No. 1	45.00 to 55.00	.....
Magnesite brick, per net ton	135.00 to 145.00	.....
Chrome brick, per net ton	135.00	.....
Deadburned magnesite brick, per net ton	85.00 to 90.00	.....
Special furnace chrome brick, per net ton	60.00 to 70.00	60.00 to 80.00

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—High grade, $55 to $65; St. Louis grade, $40 to $50.

Birmingham—Fire clay, $25 to $30; Denver, $23, per 1000.

Chicago—Second quality, $25 per ton.

FUEL OIL—Price variable, depending upon stock. New York quotations not available owing to this fact. In Chicago and St. Louis the following prices are quoted:

	Chicago	St. Louis
Domestic light, 22-26 Baumé	5c.	5½c.
Mexican heavy, 12-14 Baumé	7c.	None

Note—There is practically no fuel oil in Chicago at present time.

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Jan. 30, 1918	One Year Ago
New York	$15.00	$8.00
Cleveland	15.30	7.50
Chicago	15.00	6.00

In coils an advance of 50c. usually is charged.

Note—Stock very scarce generally.

POLES—Prices on Western red cedar poles:

	New York	Chicago	St. Louis	Denver
6 in. by 30 ft.	$5.59	$4.94	$4.94	$4.32
7 in. by 30 ft.	7.40	6.60	6.60	5.80
7 in. by 35 ft.	10.70	9.60	9.60	8.55
8 in. by 35 ft.	12.20	10.90	10.90	9.65
7 in. by 40 ft.	12.35	11.00	11.00	9.75
8 in. by 40 ft.	13.75	12.15	12.15	10.65
8 in. by 45 ft.	18.20	16.20	16.20	14.30
8 in. by 50 ft.	21.85	19.45	19.45	17.15

10c. higher freight rates on account of double loads.

For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft.	$6.00
12-in. butts, 6-in. tops, length 30-40 ft.	8.50
12-in. butts, 6-in. tops, length 41-50 ft.	9.50
14-in. butts, 6-in. tops, length 51-60 ft.	17.00
14-in. butts, 6-in. tops, length 61-71 ft.	18.50

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect July 2, 1917, for iron, and May 1 for steel:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
¾ to 3	49%	35½%	¾ to 1½	33%	17%

LAP WELD

2	42%	29½%	2	26%	12%
2½ to 6	45%	32½%	2½ to 4	28%	15%
7 to 12	42%	28½%	4½ to 6	28%	15%
13 and 14	32½%	....	7 to 8	20%	8%
15	30%	....			

BUTT WELD, EXTRA STRONG PLAIN ENDS

¾ to 1½	47%	34½%	¾ to 1½	33%	18%
2 to 3	48%	35½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	2	27%	14%
2½ to 4	43%	31½%	9 to 12	15%	3%
4½ to 6	42%	30½%	7 to 12	25%	12%
7 to 8	38%	24½%	2½ to 4	29%	17%
9 to 12	33%	19½%	4½ to 6	28%	16%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	38%	42%	34.27%
3½ to 6 in. lap welded	18%	38%	21.27%
7 to 12 in. lap welded	10%	35%	21.27%

	Galvanized		
	New York	Chicago	St. Louis
¾ to 3 in. butt welded	22%	22%	19.27%
3½ to 6 in. lap welded	List	18%	13.27%
7 to 12 in. lap welded	List+20%	20%	6.27%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

BOILER TUBES—The following are the prices for carload lots f.o.b. Pittsburgh, announced Nov. 13, as agreed upon by manufacturers and the Government:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	34	3½ to 4½ in.	+12½
2½ to 3¼ in.	24	3 to 3¼ in.	+5
2¼ in.	17½	2½ to 2¾ in.	+7½
1¾ to 2 in.	13	2 to 2¼ in.	+22½
		1¾ to 1⅞ in.	+35

Standard Commercial Seamless—Cold drawn or hot rolled:

	Per Net Ton		Per Net Ton
1 in.	$340	1¾ in.	$220
1¼ in.	280	2 to 2½ in.	190
1⅜ in.	270	2¾ to 3¾ in.	180
1½ in.	220	4 in.	200
		4½ to 5 in.	220

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.